Environmental Research and Consultancy Department
Civil Aviation Authority

ERCD Report 0705

Revised Future Aircraft Noise Exposure Estimates for Heathrow Airport

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Prepared by the Civil Aviation Authority on behalf of the Department for Transport, London, November 2007

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Summary

This document presents revised future aircraft noise exposure estimates for Heathrow airport. The work has been undertaken in support of the Department for Transport's (DfT) Consultation: Adding Capacity at Heathrow Airport. The assessment does not constitute a full environmental impact assessment; rather it attempts to identify the types of scenarios that would be compatible with the stringent criteria stated in the Air Transport White Paper. The report describes a range of new and updated scenarios for Heathrow airport, superseding those reported previously in ERCD Report 0308.

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The authors of this report are employed by the Civil Aviation Authority. The work reported herein was carried out on behalf of the Department for Transport.

Any views expressed are not necessarily those of the Secretary of State for Transport.

Population data used in this report are based on 2001 Census data (updated in 2006) supplied by CACI Information Services.

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Executive Summary

This document presents revised future aircraft noise exposure estimates for Heathrow airport. The work has been undertaken in support of the Department for Transport's (DfT) Consultation: Adding Capacity at Heathrow Airport. The assessment does not constitute a full environmental impact assessment; rather it attempts to identify the types of scenarios that would be compatible with the stringent criteria stated in the Air Transport White Paper.

The report describes a range of new and updated scenarios for Heathrow airport. Updated scenarios supersede those reported previously in ERCD Report 0308. The following scenarios have been assessed:

- Segregated-mode, i.e. (within the 480,000 air transport movement cap) in 2015 and 2030
- Mixed-mode in 2015 and 2030
- Addition of a third runway in mixed-mode with the main runways operated in segregated-mode in 2020 and 2030

As well as assessing future growth scenarios, this report also provides an assessment of the effects of removing the Cranford agreement (whilst retaining segregated-mode operation) and the effects of altering the system of westerly preference, commitments made in the Secretary of State's decision letter regarding the application for a fifth terminal at Heathrow Airport.

For each scenario, tables of contour areas, populations and household counts within each contour are provided, along with diagrams illustrating the shape and location of the noise contours. In addition noise difference contours have been generated quantifying the areas, populations and household counts subject to specific changes in noise exposure.

A summary of the results is shown below, the first table showing contour areas under specific scenarios, the second table showing populations within those contours.

Scenario	Year	Leq 16hr contour area (km²)		
		57	**63**	**69**
480,000 ATMs segregated-mode	2002	126.6	43.8	16.3
480,000 ATMs segregated-mode	2015	119.8	38.0	12.1
540,000 ATMs mixed-mode	2015	125.5	40.8	12.3
615,000 ATMs R3 MLD option	2020	126.5	36.6	10.4
670,000 ATMs R3 MDL option	2020	126.9	42.1	11.4
605,000 ATMs R3 alternating option	2020	126.7	39.8	11.1
480,000 ATMs segregated-mode	2030	77.0	26.4	7.6
540,000 ATMs mixed-mode	2030	91.1	30.0	8.7
702,000 ATMs R3 MLD option	2030	109.4	31.5	9.1
702,000 ATMs R3 MDL option	2030	105.6	33.5	9.2
702,000 ATMs R3 alternating	2030	112.9	34.2	9.8

Scenario	Year	Leq 16hr contour population (000s)		
		57	**63**	**69**
480,000 ATMs segregated-mode	2002	257.8	64.2	8.6
480,000 ATMs segregated-mode	2015	261.9	50.4	3.5
540,000 ATMs mixed-mode	2015	274.0	60.2	4.8
615,000 ATMs R3 MLD option	2020	234.5	31.6	3.9
670,000 ATMs R3 MDL option	2020	258.9	49.8	3.3
605,000 ATMs R3 alternating option	2020	242.3	35.6	3.2
480,000 ATMs segregated-mode	2030	142.2	24.4	1.6
540,000 ATMs mixed-mode	2030	181.1	34.0	2.8
702,000 ATMs R3 MLD option	2030	191.2	28.3	3.8
702,000 ATMs R3 MDL option	2030	208.9	36.0	2.3
702,000 ATMs R3 alternating	2030	205.7	31.1	2.6

The main assessment has focused on how the 16 hour average summer day L_{eq} noise exposure contours compare with 2002, the baseline defined in the Air Transport White Paper and specifically how the scenarios compare against the White Paper commitment that the 57dBA L_{eq} contour area should not exceed the 127 km^2 that it covered in 2002.

It is recognised that for some, noise exposure contours are difficult to interpret and understand, and that further away from the airport, aircraft noise may be one of many factors affecting community annoyance. In addition, because the introduction of mixed-mode or a third runway may involve significant airspace changes, the main assessment is supplemented with airport operations diagrams, providing information on the indicative flight paths and likely numbers of movements on these flight paths.

The assessment shows that mixed-mode operation providing for a total of 540,000 ATMs in 2015 could meet the White Paper limit. With regard to a possible third runway, the assessment shows that full capacity (702,000 ATMs) may *not* be realised in 2020 without significant incentives to encourage airlines to replace the current large numbers of four-engined aircraft with a greater proportion of large twin-engined aircraft. However, by 2030 the maximum capacity forecast with a third runway could be accommodated. Whilst the overall noise contour area in 2030 with a third runway is forecast to be somewhat below the 2002 level, some areas would experience noise levels considerably higher than in 2002. Such effects may be mitigated as part of a future planning application.

Finally, a preliminary indication of possible night-time effects is presented. Whilst these preliminary forecasts indicate that the introduction of a third runway might provide the opportunity to increase ATMs in the night period, the underlying assumption is that these additional movements would be contained within the shoulder periods .The continuing phase out of older noisier aircraft types, including the complete phase out of the Boeing 747-400 by 2030 likely means that even with such movement growth, the night time contour area would be comparable to the current area, although it is recognised that more detailed analysis would need to be undertaken to verify this.

Contents

Glossary of Terms

A-weighting	A frequency weighting that is applied to the electrical signal within a noise-measuring instrument as a way of simulating the way the human ear responds to a range of acoustic frequencies.
AIP	Aeronautical Information Publication (UK Air Pilot).
ANCON	The UK aircraft noise contour model.
ATMs	Air Transport Movement. Either a takeoff or a landing by an aircraft performing a passenger or cargo revenue flight.
BAA	BAA plc, the company that owns and operates, amongst others, Heathrow, Gatwick and Stansted airports.
dB	Decibel units describing sound level or changes of sound level. It is used in this report to define differences measured on the dBA scale.
dBA	dBA is used denote the levels of noise measured on an A-weighted decibel scale.
DfT	Department for Transport
ECAC	European Civil Aviation Conference
ERCD	Environmental Research and Consultancy Department
ICAO	International Civil Aviation Organization
Leq	The equivalent continuous sound level, normally measured on an A-weighted decibel scale.
MTOW	Maximum take-off weight
NATS	National Air Traffic Services Ltd. NATS provides air traffic control services at several major UK airports, including Heathrow.
NPR	Noise Preferential Route.
P-RNAV	Precision Area Navigation
RUCATSE	Runway Capacity to Serve the South East
SEL	The Sound Exposure Level generated by a single aircraft at the measurement point, measured in dBA. This accounts for the duration of the sound as well as its intensity.
SERAS	South East and East of England Regional Air Services Study

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1 Introduction

1.1 This document presents revised future aircraft noise exposure estimates for Heathrow airport. The work has been undertaken in support of the Department for Transport's (DfT) Consultation: Adding Capacity at Heathrow Airport (Ref 1). The assessment does not constitute a full environmental impact assessment; rather it attempts to identify the types of scenarios that would be compatible with the stringent criteria stated in the Air Transport White Paper (Ref 2).

1.2 The report describes a range of new and updated scenarios for Heathrow airport. Updated scenarios supersede those reported previously in ERCD Report 0308 (Ref 3). As well as assessing future growth scenarios, this report also provides an assessment of the effects of removing the Cranford Agreement (whilst retaining segregated-mode operation) and the effects of altering the system of westerly preference, commitments made in the Secretary of State's decision letter regarding the application for a fifth terminal at Heathrow Airport.

1.3 For each scenario, annual traffic forecasts were provided by BAA. The forecasts detail the numbers of movements of specific aircraft, and where relevant, engine combination by runway and departure/arrival route.

1.4 Section 2 describes the input data and methodology used in the generation of the aircraft noise exposure contours, the data sources used and how the data has changed since ERCD Report 0308. In particular, the section presents the noise performance assumptions made for future aircraft types, and briefly describes the indicative airspace designs used to generate the noise exposure contours.

1.5 Section 3 presents the assessment of aircraft noise at Heathrow Airport under the following scenarios:

- Segregated-mode, i.e. (within the 480,000 air transport movement cap) in 2015 and 2030
- Mixed-mode in 2015 and 2030
- Addition of a third runway in mixed-mode with the main runways operated in segregated-mode in 2020 and 2030

1.6 The assessment is based on 16-hour L_{eq} contours, for which the noise contour areas, populations and households enclosed are reported, along with small scale (A4) diagrams of the noise contours. Effects beyond the noise contours are addressed in section 6 (see para 1.9).

1.7 Section 4 presents the results of an analysis of difference contours, which show how noise exposure may change over time relative to 2002.

1.8 Section 5 describes an assessment of the effects of removing the Cranford Agreement (in segregated-mode operation) and of altering the system of westerly preference. The assessment is reported in terms of 16-hour L_{eq} contours, contour areas, populations and households enclosed.

1.9 Section 6 presents a series of airport operations diagrams, showing the indicative disposition of flight paths and likely numbers of aircraft using them. As well as covering the region assessed using noise contours, these diagrams extend the analysis to a much wider area and convey the information in simpler terms without direct reference to noise information.

1.10 Section 7 presents a preliminary indication of possible night time effects, considering how air traffic movements may change in the night period and night quota period over time.

1.11 Finally, Section 8 presents the conclusions of the assessment.

2 Methodology and Input Data

2.1 Methodology

2.1.1 Since 1990, the established index for relating the amount of aircraft noise exposure to community annoyance has been the Equivalent Continuous Sound Level index, or L_{eq}. In the UK this index is applied to an average summer day (taking into account traffic between mid-June and mid-September) over 16 hours, between 0700 and 2300 local time. The background to the use of this index is explained in DORA Report 9023 (Ref 4). The magnitude and extent of the aircraft noise around an airport is depicted on maps by plotting contours of constant aircraft noise exposure (L_{eq}) values. It is conventional practice to plot contours between 57 and 72dBA L_{eq} in 3dB steps. It has become general usage to describe 57, 63 and 69dBA L_{eq} as denoting low, medium and high community annoyance respectively, whilst noting that 57dBA L_{eq} is also taken to describe the onset of significant community annoyance. More recently 54dBA L_{eq} contours have also been plotted as a sensitivity test of underlying forecasts and noise performance assumptions. Populations and numbers of households within the noise contours are then estimated using 2001 Census data as updated by CACI Ltd in 2006.

2.1.2 The contours are determined by a semi-empirically validated computer model, which calculates the emissions and propagation of noise from arriving and departing air traffic. The method by which noise maps, or contours of L_{eq}, are prepared using the ANCON Noise Model is described in more detail in Ref 5. The latest version of the ANCON model incorporates internationally agreed best practice, as recommended by ECAC (Ref 6) and ICAO[1].

2.1.3 In order to determine the aircraft noise exposure levels around an airport, information is required on the types of aircraft operating, the number of movements by each aircraft type, their noise characteristics and their position in three dimensions with respect to ground locations in the vicinity of the airport. The following sections describe the various input data requirements.

2.2 Future aircraft types

2.2.1 The requirement to forecast aircraft noise exposure to 2030 necessitates the definition of future aircraft types and their associated noise characteristics. Historical trends clearly show that each generation of aircraft are quieter than their predecessor, significantly so in some cases. This is a reflection of the introduction of new technologies, of which some are aimed purely at reducing aircraft noise, whilst others are, for example, aimed at reducing fuel burn which also contributes towards reducing noise exposure. This changing of noise performance over time also necessitates the need to take into account how the aircraft fleet will change over time.

2.2.2 **Table 2.1** identifies several new types that are not yet in service or, in some cases, are not even confirmed for production. In the latter case, their inclusion is based on expected technological advances and market trends. In the former case, a good deal of information is available about many of the proposed new types. The following paragraphs describe the basic characteristics of these future types. It should be

[1] A replacement for ICAO Circular 205 is in final preparation and will accord with ECAC Document 29 3rd Edition.

stressed that, whilst most of these types are either about to enter service or in the final stages of design, some are simply projections.

Table 2.1: Future aircraft types defined for forecasting purposes

Future Type	MTOW (tonnes)	Typical Passenger Capacity	Entry into service
Airbus A380	560	555	2007
Boeing 747-8	440	467	2010
New technology 120 seat	60	120	2015
New technology 150 seat	75	150	2015
New technology 180 seat	90	180	2015
New technology 220 seat	98	220	2015
New technology 220 seat long-haul	220	220	2008
New technology 250 seat long-haul	245	250	2010
New technology 300 seat long-haul	270	300	2011-12
New technology 300 seat short-haul	165	300	2010
New technology 450 seat twin	370-390	450	>2020

2.2.3 The Airbus A380 entered service last month. Typically the aircraft will offer 35 percent more seats than the current largest passenger aircraft, the Boeing 747-400, and is aimed at replacing aging 747-400s, whilst also offering the potential for passenger growth at slot-constrained airports.

2.2.4 Boeing has presented many designs in the search for a successor to its 747-400. The 747-8 variant was launched in 2005 and incorporates a relatively small fuselage stretch raising passenger capacity to around 470, a new wing offering significant aerodynamic improvements over the -400 and new engines derived from those powering the 787, both factors contributing to reduce noise levels compared with today's 747-400 model.

2.2.5 Although the Boeing 737 Next Generation (NG) and Airbus A320 families of short-haul narrow-body aircraft continue to sell well, both manufacturers are actively pursuing design studies for successor aircraft families. It is unlikely that any new family will enter service before 2015. The aircraft are expected to offer similar passenger and range capabilities as current family variants, whilst offering fuel, noise and emissions savings, together with reduced operating costs.

2.2.6 The New Technology 220, 250 and 300 seat long-haul aircraft, together with the 300 seat short-haul aircraft represent categories for which Airbus is offering variants of the A350 XWB and Boeing the 787. Both aircraft are envisaged to replace Boeing 767, Airbus A300/310 aircraft, and aging A340 aircraft, whilst offering similar passenger and range capabilities across a family of variants. The Boeing 787 will be the first to fly and is currently scheduled to enter service in 2008. This is an all-new design; the airframe is made entirely of composite materials and will include new engine designs.

2.2.7 The new technology 450 seat aircraft represents a longer term replacement for Boeing 747-400 and Airbus A340 aircraft, but continuing the migration to a twin-engined design as seen in the 200-350 seat aircraft sector.

2.3 Aircraft Noise/Performance Assumptions

Existing aircraft

2.3.1 For existing aircraft types, radar data and noise measurements are collected from around Heathrow Airport. The radar data is used to generate aircraft performance information and hence the source noise emission associated with aircraft operations, whilst the noise measurements allow for validation of the aircraft noise source and propagation characteristics. An illustration of the techniques used in processing radar and noise monitoring data, including an illustration of recent noise monitoring locations used by ERCD is provided in ERCD Report 0406 (Ref 7).

2.3.2 This data is reviewed and updated annually as part of the generation of average summer day noise contours. Collecting local data and reviewing it on a regular basis ensures that the ANCON databases reflect local practices and procedures, such as the requirements stipulated in the Aeronautical Information Publication (AIP) (Ref 8). For the analysis undertaken in support of the Air Transport White Paper, information relating to existing aircraft types was based on radar data and noise measurements for 2002. For this assessment, the latest information available on mean flight tracks and aircraft noise and performance information for 2006 has been used.

Future aircraft

2.3.3 Historically, aircraft of a given size have become quieter with every successive generation. **Figure 2.1** provides an illustration of the significant progress made in reducing source noise since the introduction of jet transport aircraft in the late 1950s. Whilst the overall size of aircraft continues to grow, noise levels for individual aircraft are progressively being capped by international regulation and local operating restrictions.

2.3.4 New Chapter 4 noise certification standards were introduced from 1 January 2006, ensuring that the latest available technology is incorporated into new aircraft designs. A direct example of this is the incorporation of a Noise Improvement Package (NIP) on certain variants of the Airbus A320 family aircraft.

2.3.5 For larger aircraft, local airport restrictions, such as the London airports night noise Quota Count (QC) scheme continue to put pressure on industry to reduce noise of larger aircraft far beyond international certification requirements. The recent decision to limit the scheduling of operations during the night quota period to aircraft with a QC rating of 2 or less has resulted in the departure noise levels of large aircraft being capped at below QC/2. As a result, the Airbus A380 has been designed such that it generates no more departure noise than an Airbus A340-200/300 despite being more than twice the size.

2.3.6 Long-term industry research programmes continue to identify new and emerging technologies that may be incorporated on new generation airliners. Boeing has recently flown three Boeing 777 Quiet Technology Demonstrator (QTD) programmes, flight testing technologies for future programmes, some of which will enter into service on the 787. The Advisory Council for Aeronautics Research in Europe (ACARE) has established a Strategic Research Agenda (SRA) that includes Vision2020 goals. These goals include the reduction of source noise by 10dB by 2020 relative to a year 2000 baseline.

2.3.7 In summary, significant research is ongoing, with which it is possible to identify noise characteristics of the next generation of airliners.

Application to Modelling

2.3.8 The same approach has been used as in previous assessments and described in ERCD Report 0307 (Ref 9). For each future aeroplane type, an explicit 'surrogate' has been chosen, a similar aircraft type whose certificated noise levels are known. For a given future type, the noise model data for this surrogate aircraft are then adjusted based on the differences between the future type's predicted certification data and the surrogate aircraft's known data.

2.3.9 For example, the Airbus A380 has been modelled using the Boeing 747-400 as a surrogate type. A comparison of noise certification levels shows that the A380 is 4.45dB quieter on departure and 5.8dB on approach. Thus the A380 was actually modelled by subtracting 4.45dB from the B747-400 departure noise levels and 5.8 dB from the B747-400 approach noise levels. An explicit assumption of this method is that the relationship between certification and operational noise impact of the surrogate aircraft type applies to the new aircraft type. By choosing the most appropriate surrogate type (*e.g.* matching a four-engined type to another four-engined type) this assumption should be robust.

2.3.10 There are no specific noise certification details available at this time for the next generation of narrow-body airliners to replace the Airbus A320 and Boeing 737NG family. Thus proposing separate characteristics for Airbus and Boeing variants is not considered justifiable or appropriate. Technologies adapted from the Boeing 787, e.g. composites and aerodynamic improvements, will improve the overall efficiency of the airframe. Entirely new engine families are likely to be offered, Pratt & Whitney already proposing a geared-turbofan which will offer significant fuel and noise reduction benefits. Building on the ACARE goals, commonly quoted targets include cumulative certification noise levels 25dB beyond the Chapter 3 noise limits (i.e. 15dB beyond Chapter 4). High weight variants of the current aircraft families have a margin of 1-3dB relative to Chapter 4. For this assessment, a relatively cautious cumulative reduction of 10dB beyond existing Airbus A320 family aircraft has been assumed.

2.3.11 The next generation 220-300 seat wide-body airliners are much more mature in design. Boeing has given guarantees of a QC/1 rating for variants of its 787 family. However, information provided by Boeing to the 2006 Stansted Noise Seminar suggests that departure noise levels for the 787 family will be towards the bottom of the QC/1 category. Taking this into consideration, cumulative certificated noise levels are expected to be around 25dB below Chapter 3 levels. To put this in context, some variants will produce a similar amount of noise to variants within the current 150-180 seat aircraft families, e.g. A320/321 and B737-800/900.

2.3.12 Continuing research, such as the European ACARE programme will likely lead to significant new technologies being applied to a larger generation of wide-body twin-engined airliners to replace the current largest twin-engined airliner, the Boeing 777-300ER, which entered service in 2004. On this basis the new technology 450 seat aircraft is envisaged to have a cumulative margin relative to Chapter 3 of around 25dB, compared with 16dB for the Boeing 777-300ER.

2.3.13 **Table 2.2** summarises the surrogate types and adjustment factors used for each forecast aircraft type.

Table 2.2: Surrogate aircraft types and adjustment factors for future aircraft types

Type	Surrogate	Departure Adjustment	Arrival Adjustment
Airbus A380	Boeing 747-400 GE	-4.45	-5.80
Boeing 747-8	Boeing 747-400 GE	-3.50	-3.00
New technology 120 seat	Airbus A319C	-4.00	-3.00
New technology 150 seat	Airbus A320C	-4.00	-3.00
New technology 180 seat	Airbus A321C	-4.00	-3.00
New technology 220 seat	Airbus A321C	-3.50	-2.00
New technology 220 seat long-haul	Boeing 767-300 GE	-3.70	-1.70
New technology 250 seat long-haul	Boeing 767-300 GE	-3.70	-1.70
New technology 300 seat long-haul	Boeing 767-300 GE	-2.70	-1.70
New technology 300 seat short-haul	Boeing 767-300 GE	-4.20	-1.70
New technology 450 seat twin	Boeing 777-300 GE	-4.00	-2.00

2.3.14 Based on the data in table 2.2, **Figure 2.2** compares selected departure noise footprints in comparison with existing representative aircraft types. The Boeing 747-400 90dBA SEL departure footprint covers an area of 17.7km². The departure footprint areas for the Boeing 747-8 and Airbus A380 are 9.3 and 7.7km² respectively, clearly illustrating the improved noise performance of these aircraft, despite both aircraft being larger, with the A380 expected on average to offer 35 percent more seats than a Boeing 747-400.

2.3.15 Comparing wide-body twin jets, the new technology 300 seat long-haul twin has an estimated departure footprint area of 4.3km² compared with 7.4km² for a Boeing 767-300ER. Finally, comparing an example from the narrow-body short-medium haul market segment, the new technology 150 seat twin has an estimated departure footprint area of 1.8km² compared with 3.7km² for an Airbus A320.

2.4 Segregated-mode airspace design

2.4.1 As already stated in para 2.3.2, the airspace design used for the base case maximum-use scenarios is based on mean flight tracks computed from 2006 radar data and used in the average summer day noise contours published in ERCD Report 0701 (Ref 10).

2.4.2 However, the dispersion of flight paths about the 2006 mean tracks has been adjusted to reflect the likely introduction of P-RNAV procedures within the timescales of the scenarios being assessed. Although the implementation is not a pre-requisite for the base case maximum-use scenarios, unlike mixed-mode or the introduction of a third runway, additional flights elsewhere within the London Terminal Control Area (LTMA) and a ongoing desire to improve the safety and efficiency of the LTMA will likely lead to its implementation irrespective of traffic growth at Heathrow.

2.4.3 P-RNAV procedures have not yet been implemented for departures, thus there is no historical information to rely on. Instead, flight track dispersion data was analysed for a subset of 2006 data relating to P-RNAV equipped aircraft. Whilst this provides information on the navigational accuracy of such aircraft, it does not provide information as to what degree of 'tactical' vectoring will take place once aircraft have reached 4,000ft. For this assessment, no further adjustments have been made to account for this. The same dispersion data has been applied to both mixed-mode and three-runway scenarios.

2.4.4 The mean departure tracks used for the segregated-mode base case scenarios are illustrated in **Figure 2.3**.

2.5 Mixed-mode airspace design

2.5.1 Following significant design work by NATS, a mixed-mode airspace design was provided for purposes of noise modelling. The design remains indicative and would be subject to further detailed design work and consultation in line with the requirements of CAP 725 (Ref 11).

2.5.2 The indicative departure flight tracks are illustrated in **Figure 2.4**. With the exception, of two departure routes (Compton (CPT) during westerly operations and Dover (DVR) during easterly operations), the routes are runway specific, thus providing for independent operation of the runways.

2.5.3 Some changes would also be required to the arrival flight paths. The intercept point on the extended runway centreline would likely move out by approximately 5 nm. Advice also indicated that safety requirements in mixed-mode would require aircraft to be vertically separately at the ILS intercept point by 1,000ft. For the purposes of this analysis it was assumed that this would require aircraft approaching from the south to operate in level flight for around 5-8 nm precluding the possibility of offering continuous descent approaches from the south.

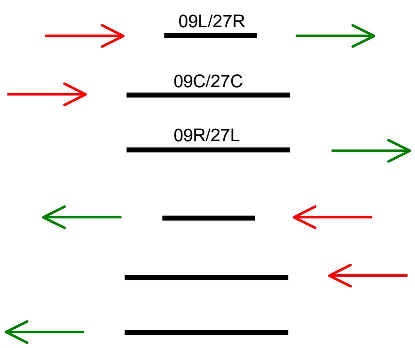
2.6 Runway 3 airspace designs

2.6.1 As with mixed-mode, NATS has undertaken significant design work on potential airspace designs in order to accommodate a short third runway. This design work showed that it is not possible to operate the two main runways in mixed-mode, whilst at the same time operating a third runway in mixed-mode. Thus a range of designs was narrowed down to an indicative airspace arrangement with mixed-mode operation on a third runway and segregated-mode operation on the two main runways.

2.6.2 Implementing segregated-mode on the two main runways, leads to the potential for two main operating modes, with the potential for alternation (much as is practised today during westerly operations), resulting in a third potential operating mode with three runways.

2.6.3 For the first option, runway three would be operated in mixed-mode, whilst the existing northern runway would be used for arrivals, the existing southern runway used for departures. For the main runways, this mode of operation is essentially the same as used currently. Describing the operating modes of the runways from 'top' to 'bottom', we have mixed-mode, landings, and departure respectively. Thus, this option has been termed MLD. During easterly operation, this option would have the potential to respect the Cranford Agreement. The operating modes during easterly and westerly operation are shown below.

Runway 3 Option MLD

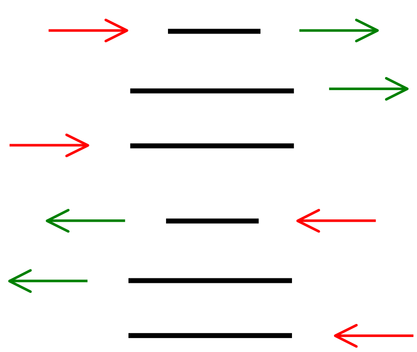


- Easterly departures on 09L and 09R
- Easterly arrivals on 09C and 09L

- Westerly departures on 27R and 27L
- Westerly arrivals on 27R and 27C

2.6.4 Swapping the operating mode of the main runways provides an additional potential way of operating all three runways. Under this scenario departures would operate from the existing northern runway and arrivals would land on the southern runway. Mixed-mode operation would remain unchanged on runway three. Describing the operating modes as before, we have mixed-mode, departures and landings respectively. Thus this option has been termed MDL.

Runway 3 Option MDL



- Easterly departures on 09L and 09C
- Easterly arrivals on 09R and 09L

- Westerly departures on 27R and 27C
- Westerly arrivals on 27R and 27L

2.6.5 The third operating mode with runway three is simply an alternating variant of Options MLD and MDL. It is envisaged at this stage that alternation would be implemented in the same way as today, with the main runways changing use at 3pm each day and also alternating between morning and evening usage on a weekly basis.

2.6.6 Indicative departure flight tracks associated with Options MLD and MDL are shown in **Figures 2.5 and 2.6 respectively**. In order to implement mixed-mode on runway three, its departure routes need to be independent of the two main runways. As a result some of the existing departure routes are not feasible on runway three (similar to the mixed-mode designs).

2.7 Air traffic forecasts

2.7.1 Air traffic forecasts have been provided by BAA for the following scenarios:

- Segregated-mode within the 480,000 air transport movement cap in 2015 and 2030
- With mixed-mode use of the existing runways in 2015 and 2030
- With a third runway in 2020 and 2030.

2.7.2 The air traffic movement forecasts have been provided for a 16-hour average summer day (0700-2300) and for annual average night period (2300-0700). Use of the latter is discussed in section 7. The 16-hour average summer day forecasts form the basis of the noise assessment. The forecasts detail the number of movements by aircraft type, runway and departure route. Because of differing runway/departure route structures associated with mixed-mode or a third runway, extensive surface movement modelling was required before the forecast could be finalised.

2.7.3 Whilst the total movements listed against each scenario in this report relate to the total number of air transport movements (which include both passenger and cargo air transport movements), the noise contours presented in this report also include non-revenue air traffic movements (e.g. positioning flights) and general aviation movements.

2.7.4. **Table 2.3** provides a breakdown of the total air traffic movements for each of the scenarios listed in para 2.7.1. Corresponding numbers for 2006, taken from ERCD Report 0701 are also provided for context.

Table 2.3: 16-hour average summer day air traffic forecasts for each scenario

Seat Cat.	Aircraft Type	2006	SM 2015	SM 2030	MM 2015	MM 2030	R3 2020	R3 2030
1	Bombardier Regional Jet	5.4	0.7	0	2.3	0	0	0
1	Business Jet (Ch. 3)	5.3	2.7	2.7	4	2	4	4
1	Embraer EMB 135/145/170	17	0.7	0	2.3	0	0	0
1	Small/Large Props	8.4	0.5	0.5	0	0.4	1	0
Subtotal		**36.1**	**4.6**	**3.2**	**8.6**	**2.4**	**5**	**4**
2	Airbus A318	3.3	0	0	0	0	0	0
2	Airbus A319/320/321	647.3	682.7	122.3	821	159.6	656	28
2	BAe 146	3.4	0	0	0	0	0	0
2	Boeing 737	66.2	44.4	0	57	2.5	6	19
2	Embraer 190	0	0.7	0	2.3	0	0	0
2	Fokker 100	2.4	0	0	0	0	0	0
2	Boeing MD80	29.8	0	0	0	0	0	0
2	Next Generation – 120/150 seat	0	0	89.4	0	224	148	396
Subtotal		**752.4**	**727.8**	**211.7**	**880.3**	**386.1**	**810**	**443**
3	Airbus A300	12.8	0	0	6	0	0	0
3	Airbus A310	5.9	0	0	0	0	0	0
3	Boeing 757-200/300	56.4	7	0	2	0	2	0
3	Boeing 767-200/300	62.3	6.6	0	2	0	0	0
3	Boeing MD90	0	0	0	0	0	0	0
3	Next Generation - 180 seat	0	0	211.7	0	184.2	103	507
3	Next Generation - 220 seat	0	1.8	230.6	14	325.9	372	330
Subtotal		**137.4**	**15.4**	**442.3**	**24**	**510.1**	**477**	**837**
4	Airbus A330-200/300	34.1	46.5	0.1	45	1.2	6	0
4	Airbus A340-200/300	35.3	7.5	0	6	0	2	0
4	Boeing 777-200	105.2	87.7	0.1	161	8.8	39	6
4	Next Generation – 250/300 Seat	0	45.6	244.6	66	183.7	190	252
4	Boeing MD11	0.9	0	0	0	0	0	0
4	Others	0.6	0	0	0	0	0	0
Subtotal		**176.1**	**187.3**	**244.8**	**278**	**193.7**	**237**	**258**
5	Airbus A340-500/600	21.2	56.7	5.3	39	0	20	0
5	Boeing 747-100/200/300/SP	5.4	0	0	2	0	0	0
5	Boeing 747-400	110.6	72.7	0	62	0	4	0
5	Boeing 747-8	0	4.2	8.6	5	81	119	11
5	Boeing 777-300	8.7	133.3	93.1	106	102	148	138
5	Next Generation - 450 seat	0	0	121.6	0	55.4	0	119
Subtotal		**145.9**	**266.9**	**228.6**	**214**	**238.4**	**291**	**268**
6	Airbus A380-800	0	74.8	146.1	46	123.2	91	98
Subtotal		**0**	**74.8**	**146.1**	**46**	**123.2**	**91**	**98**
Total		**1248**	**1277**	**1277**	**1451**	**1454**	**1911**	**1908**

SM Segregated-mode use of existing runways
MM Mixed-mode use of existing runways
R3 Third runway operated in mixed-mode, main runways operated in segregated-mode

2.8 Summary of modelling assumptions and input data

2.8.1 Tables 2.4 and 2.5 provide a summary of the noise/performance and modelling assumptions used for the assessment. The status of the assumption is described relative to those stated in ERCD Report 0307.

Table 2.4: Summary of aircraft noise/performance assumptions

Parameter	Assumption	Status
Noise characteristics for existing types	Based on aircraft performance and noise measurements (from year 2006) for existing aircraft types.	Updated from 2002
Noise characteristics for future types	Aircraft performance and noise data for future types revised as described in Section 2.3	Revised
Operating procedure	Based on ANCON year 2006 database (*i.e.* from observations of radar data at London Heathrow Airport). Assumed to remain fixed over time.	Updated from 2002
New noise standard	No explicit assumption regarding a future noise standard. Noise performance of future types defined based on current trends and available technology.	Revised
Non-production rule	No explicit assumption regarding non-production, other production of certain aircraft types ceases once successor types introduced into service.	Revised
Phase-out (noise)	No phase-out rule assumed. Aircraft types assumed to be retired based on typical ‘economic’ life.	Revised

Table 2.5: Summary of noise modelling assumptions

Parameter	Assumption	Status
ANCON L_{eq} noise exposure model	ANCON Version 2.3 as used to generate year 2005 & 2006 London airports’ historical noise contours.	Revised
Runway modal split	Based on 20-year average for Heathrow airport	Modal split 76%W/24%E, compared with 77%W/23%E
Airport route structure	Mixed-mode and Runway 3 airspace designs based on information provided by NATS as described in sections 2.5 and 2.6 respectively.	Revised
Track dispersion	Based on analysis of radar data from 2006 of a subset of modern aircraft types (B777, A340), reflecting likely PRNAV track dispersion.	Revised
Glide slope	International Standard 3°	Unchanged
Population database	Based on 2001 Census data as updated by CACI Ltd in 2006. No change over time beyond that year.	Revised, 1999 population data used previously.

3 Noise Assessment

3.1 2002 Baseline (461,000 ATMs)

3.1.1 The Air Transport White Paper made it clear that any further development of Heathrow Airport would not be expected to increase the 57dBA L_{eq} contour area beyond 127km^2, the value in 2002. In 2002, Heathrow Airport handled just over 461,000 ATMs and 63 million passengers. The noise contour areas, populations and household counts for 2002 are provided in **Table 3.1** as context for the scenarios that will follow. The 2002 16-hour L_{eq} contours are illustrated in **Figure 3.1**.

Table 3.1: 2002 461,000 ATMs standard-mode contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	126.6	257.8	107.6
> 60	71.7	123.3	50.1
> 63	43.8	64.2	25.6
> 66	28.8	29.7	11.6
> 69	16.3	8.6	3.3
> 72	8.4	3.0	1.2

3.1.2 The contour areas in Table 3.1 depict the culmination of the progressive introduction of Chapter 3 aircraft and the phase-out of noisier Chapter 2 aircraft in the preceding decade, such that ten years earlier the 57dBA L_{eq} contour covered an area of 204 km^2 and encompassed 372,000 people.

3.2 2015 Base case: 480,000 ATMs on existing runways

3.2.1 The Terminal Five decision letter capped the Air Transport Movements (ATMs) at 480,000 per annum. The 2015 base case scenario reflects this planning condition. In terms of an average summer day (0700-2300), air traffic movements increase to 1,277 compared with 1,248 in 2006. **Table 3.2** shows the contour areas, populations and household count estimates. The noise exposure contours are shown diagrammatically in **Figure 3.2**.

Table 3.2: 2015 480,000 ATMs base case noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	119.8	261.9	110.7
> 60	65.0	105.2	42.3
> 63	38.0	50.4	19.9
> 66	22.8	15.1	5.7
> 69	12.1	3.5	1.4
> 72	6.5	0.9	0.4

3.2.2 The results in Table 3.2, show that the noise contour areas in 2015 are expected to be slightly smaller than in 2002, although representing a small increase relative to

2006 (118.7km^2). The population within the 57dBA L_{eq} contour is also predicted to increase slightly compared with 2002, rising from 257,800 to 261,900 people, despite the reduction in contour area. This is primarily due to a predicted change in the shape of the noise contours compared with that in 2002. Closer to the airport population reductions are more significant, again due to change in contour shape, although this is partly because 2002 was an atypical year with an unequal distribution of movements on the two runways where a greater proportion of arrivals used the northern runway during westerly operation and hence a greater proportion of departures used the southern runway. This is illustrated by comparing Figure 3.2 with Figure 3.1, which shows that westerly arrival noise has reduced along the northern runway out towards Barnes, but has increased along the southerly approach path over Isleworth and north Richmond.

3.2.3 Departure noise has changed along many of the departure routes due to a redistribution of movements across different departure routes. This is particularly apparent on the westerly Dover (DVR) route around Egham, although the change in noise exposure here is also due to the tighter dispersion associated with P-RNAV operations, which has tended to narrow, but elongate contour lobes on departure routes. Along the westerly Brookmans Park (BPK) and Wobun (WOB) departure routes (heading north-west towards Slough) noise exposure is predicted to remain unchanged from that in 2002. Along the westerly Compton (CPT) and Southampton (SAM) departure routes noise exposure decreases by around 1.5dB, mainly due to forecast fleet mix changes and partly due to the greater use of the southern runway for departures in 2002.

3.3 2015 Mixed-mode (540,000 ATMs)

3.3.1 Modelling analysis work undertaken by NATS and BAA suggests that the maximum throughput achievable with mixed-mode is 540,000 ATMs (546,000 total movements). The resulting noise contour areas, populations and household count estimates are shown in **Table 3.3**. The noise contours are illustrated in **Figure 3.3**.

Table 3.3: 2015 540,000 ATMs mixed-mode noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	125.5	274.0	117.1
> 60	71.0	126.7	51.3
> 63	40.8	60.2	23.7
> 66	23.3	20.5	7.9
> 69	12.3	4.8	1.8
> 72	6.7	1.2	0.4

3.3.2 The 57dBA L_{eq} contour area is seen to be just below the 127km^2 White Paper test. However, compared with the 2015 segregated-mode scenario and 2002, the population within the 57dBA L_{eq} contour is predicted to rise slightly, reflecting the different shape of the noise contours resulting from the mixed-mode airspace design.

3.3.3 Along the westerly arrival flight paths, noise exposure levels increase by around 0.5dB. This results from an increase in daily arrival movements from 621 for segregated-mode to 708 per day in mixed-mode, which breaks down to 311 arrivals per runway in segregated-mode and 354 with mixed-mode.

3.3.4 It should be noted that the segregated-mode movements are much more concentrated. Because of alternation in segregated-mode, the 311 arrival movements are experienced over 8 hours, between either 0700-1500 or 1500-2300 depending on the week of alternation. In contrast the 354 arrival movements with mixed-mode would be spread over the full 16-hour day. Thus whilst arrival aircraft noise will be apparent over the whole day, it will be much less concentrated than at present.

3.3.5 A similar effect is apparent with respect to departure operations, although here the departure noise exposure is dominated by the fact that many departure routes become runway specific and therefore with mixed-mode the fleet mix differs between the runways. **Figure 3.4** presents an overlay of the 57dBA Leq contour for two scenarios: 2015 540,000 mixed-mode contours and the 480,000 segregated-mode contours (Figures 3.2 and 3.3). The 2002 contour is also shown for comparison purposes. The effect of departure operations on the northern runway during easterly operations is readily apparent, with the contour lobes expanding around Harlington and out over Osterley Park. To the south-east the change in location of departure routes results in some redistribution of departure noise exposure, reducing in some areas around Feltham, whilst increasing in parts of Twickenham.

3.3.6 To the south-west, an increase in the number of movements on the Dover (DVR) departure route, combined with less track dispersion causes the tip of the contour to extend further out around Egham.

3.4 2020 With a third runway (605,000 – 670,000 ATMs)

3.4.1 Modelling analysis work undertaken by NATS and BAA initially suggested that the maximum throughput achievable with a third runway is 725,000 ATMs, this comprising of 480,000 ATMs on the two main runways and 245,000 ATMs on a third runway. Early modelling work identified that such a scenario would result in a 57dBA L_{eq} contour area between 134 and 147km^2 depending on the airspace option and therefore would not meet the Air Transport White Paper test that the 57dBA L_{eq} contour area be no greater than 127km^2. The BAA forecast was scaled back to such a point where the contour would meet the White Paper test. This corresponded to around 615,000 ATMs for the MLD option, 670,000 ATMs for the MDL option and 605,000 ATMs for the alternating option. Movements of large four-engined aircraft dominate noise exposure and their numbers in 2020 will be particularly dependent on airline phase-out practice and whether the current large numbers of four-engined aircraft are replaced on a like for like basis or with a greater proportion of large twin-engined aircraft. Were a higher proportion of these aircraft to be replaced by twin-engined aircraft, then the total ATMs may increase, likewise if fewer of these aircraft were replaced with twin-engined types, the total ATMs may decrease below these estimates. For the scenario analysed here, the breakdown of movements across the runways is as follows:

- Option MLD: 407,000 ATMs main runways, 208,000 ATMs R3
- Option MDL: 444,000 ATMs main runways, 226,000 ATMs R3
- Alternating: 401,000 ATMs main runways, 204,000 ATMs R3

3.4.2 The resulting noise contour areas, populations and household count estimates are shown in **Tables 3.4, 3.5** and **3.6** for each option respectively. The noise contours are illustrated in **Figures 3.5, 3.6** and **3.7** respectively.

Table 3.4: 2020 615,000 ATMs with a third runway (option MLD) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	126.5	234.5	97.3
> 60	66.1	84.4	33.3
> 63	36.6	31.6	12.2
> 66	19.3	11.3	4.3
> 69	10.4	3.9	1.5
> 72	5.8	1.4	0.5

Table 3.5: 2020 670,000 ATMs with a third runway (option MDL) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	126.9	258.9	107.6
> 60	72.6	122.6	48.7
> 63	42.1	49.8	20.0
> 66	21.3	17.4	7.1
> 69	11.4	3.3	1.6
> 72	6.2	0.8	0.4

Table 3.6: 2020 605,000 ATMs with a third runway (alternating) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	126.7	242.3	99.7
> 60	69.9	101.6	39.8
> 63	39.8	35.6	14.0
> 66	21.3	9.5	3.9
> 69	11.1	3.2	1.3
> 72	6.1	0.3	0.1

3.4.3 The assessment of the scenario with a third runway in 2020 suggests that aircraft noise will be a constraint on airport capacity in so much that full use of all three runways results in a 57dBA L_{eq} contour area far exceeding the White Paper test of 127km^2. By scaling back the basic 2020 forecast in a uniform manner, the level of air transport movements that might be realised has been estimated to be between 605,000 and 670,000 ATMs. The variation in movements estimated relates to how the different operating options tend overall, to concentrate or spread out operations and thus displace noise between different contour levels. Option MDL concentrates the two departure streams (see para 2.6.4) close together and this tends to minimise the size of the 57dBA L_{eq} contour area, although the specific shape of the contour results in the highest population exposure of the three options. Option MLD, spreads departure noise to the two outer runways and thus for the scenarios analysed, results in a larger 57dBA L_{eq} contour area for a given number of movements. Finally, the alternating option, which would alternate between MDL and MLD spreads departure and arrival noise more widely, partly due to alternation, and thus is estimated to result in the lowest number of movements that would meet the White Paper test.

3.4.4 **Figure 3.8** which overlays the 57dBA L_{eq} contour areas for three operating modes highlights that the noise contours have vastly different shapes, depending on the runway used for departures and arrivals. Under all three options, contour lobes to the north of the airport reflect arrival and departure operations on the third runway. Newly exposed noise areas within the 57dBA L_{eq} contour area include areas extending out to Brentford and Gunnersbury Park, affected by westerly arrival noise. Although this represents a large population centre, the rest of the approach path inside the 57dBA L_{eq} contour is sparsely populated (compared with west London) and for a large part includes the M4 motorway corridor. To the west of the airport, independent operations force all departures from the third runway to head in a north-westerly direction after takeoff, resulting in newly affected areas in Richings Park and Langley Park. To the east of the airport departures from a third runway would result in newly affected noise areas to the south-west of Southall.

3.4.5 The different options of operation also affect the shape of the noise contours around the two main runways. With MLD, westerly arrivals use the existing northern runway, increasing arrival noise exposure (comparable to the level in 2002), whilst significantly reducing noise exposure under the southern runway approach path. In contrast departure noise exposure increases significantly to the south-east and south-west of the airport due to the concentration of departure operations on the southern runway, with noise exposure levels increasing beyond those in 2002, whilst decreasing elsewhere, the effects tending to be very localised. With MDL the situation is more or less reversed, with westerly arrival noise concentrated along the southern runway centreline over Hounslow, Isleworth, and Putney.

3.4.6 With the alternating mode of operation, the pronounced effects of MDL and MLD are reduced. Under the westerly arrival path, the 57dBA L_{eq} contour extends out to North Sheen, Mortlake and Kew, a lesser distance than for either the mixed-mode or segregated-mode scenarios in 2015. This is partly due to fleet replacement, but also because under this scenario, the number of movements on the main runways has reduced to around 401,000 ATMs compared with 480,000 (segregated-mode) and 540,000 ATMs under mixed-mode. In terms of daily arrival movements this equates to 491 movements per 16-hour day, compared with 621 and 708 per day in segregated and mixed-mode respectively. Under these scenarios, average daily arrival movements on the third runway are estimated to be 208, 226 and 204 per day for MLD, MDL and the ‘alternating’ mode respectively.

3.5 2030 Base case: 480,000 ATMs on existing runways

3.5.1 As for the 2015 base case scenario, this option is capped at 480,000 ATMs. Although total movements remain unchanged, the later timeframe allows for significant portions of the fleet to be retired and replaced with newer and quieter types. The resulting noise contour areas, populations and household count estimates are shown in **Table 3.7**. The noise contours are illustrated in **Figure 3.9**.

Table 3.7: 2030 480,000 ATMs base case noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	77.0	142.2	59.0
> 60	44.2	66.3	26.2
> 63	26.4	24.4	9.5
> 66	14.9	6.7	2.6
> 69	7.6	1.6	0.6
> 72	4.1	0.0	0.0

3.5.2 The continued replacement of aircraft with more modern variants and, in particular the switch to larger twin-engined types, contribute to significantly reduce the area of the noise contours compared with the same scenario in 2015. The 57dBA L_{eq} contour area is estimated to be 40 percent smaller than in 2002, with the population reducing to just over 142,000 (-45%). The 57dBA L_{eq} contour is contained entirely within the 2002 57dBA L_{eq} contour, although the amount of noise reduction relative to 2002 varies due to differences in the number and mix of aircraft forecast to operate on each departure route; in some areas the 57dBA L_{eq} contour is inside the 2002 60dBA L_{eq} contour, elsewhere it is closer to the 57dBA L_{eq} contour.

3.6 2030 Mixed-mode (540,000 ATMs)

3.6.1 As with the 2030 base case, the 2030 mixed-mode scenario represents an unchanged number of ATMs compared with mixed-mode in 2015 (540,000 ATMs), but significant fleet changes occur due to retirement and replacement with newer and quieter types. The resulting noise contour areas, populations and household count estimates are shown in **Table 3.8**. The noise contours are illustrated in **Figure 3.10**.

Table 3.8: 2030 540,000 ATMs Mixed-mode noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	91.1	181.1	76.1
> 60	51.9	88.7	35.1
> 63	30.0	34.0	13.3
> 66	16.7	11.1	4.1
> 69	8.7	2.8	1.1
> 72	4.7	0.1	0.0

3.6.2 The 57dBA L_{eq} contour area is forecast to reduce to 91.1 km^2 from 125.5 km^2 for the same scenario in 2015, a reduction of 28 percent compared with 2002. As with the segregated-mode scenarios, the contour areas reduce due to the phase-out of older noisier aircraft and the continued switch to larger twin-engined types.

3.6.3 Although the overall contour size is smaller than in 2002, the mixed-mode airspace design and different distribution of movements across departure routes results in higher noise exposure than in 2002 in two areas. The 57dBA L_{eq} extends beyond 2002 east of Egham (south-west of Heathrow) due to a forecast increase in traffic on the Dover (DVR) route and a reduction in track dispersion. Secondly the contour extends under the westerly arrival route for the southern runway. This is due to the fact that because of maintenance work, fewer aircraft used the southern runway for landing in 2002. Elsewhere noise exposure levels are below those in 2002.

3.7 2030 With a third runway (702,000 ATMs)

3.7.1 This scenario represents 702,000 ATMs in 2030. The movements are split with 235,000 ATMs to the third runway and 467,000 ATMs to the two main runways. The resulting noise contour areas, populations and household count estimates are shown in **Tables 3.9, 3.10** and **3.11** for options MLD, MDL, and 'alternating' respectively. The noise contours are illustrated in **Figures 3.11, 3.12** and **3.13** respectively.

Table 3.9: 2030 702,000 ATMs with a third runway (option MLD) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	109.4	191.2	78.7
> 60	57.1	67.7	26.6
> 63	31.5	28.3	10.9
> 66	16.7	11.1	4.1
> 69	9.1	3.8	1.4
> 72	5.1	1.2	0.4

Table 3.10: 2030 702,000 ATMs with a third runway (option MDL) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	105.6	208.9	85.6
> 60	59.4	90.4	36.1
> 63	33.5	36.0	14.5
> 66	17.0	11.9	5.0
> 69	9.2	2.3	1.1
> 72	5.2	0.5	0.2

Table 3.11: 2030 702,000 ATMs with a third runway (alternating) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	112.9	205.7	84.4
> 60	62.2	86.6	33.9
> 63	34.2	31.1	12.2
> 66	18.4	8.1	3.3
> 69	9.8	2.6	1.1
> 72	5.4	0.2	0.1

3.7.2 For all three cases with a third runway in 2030, the contour areas are smaller than those in 2020 despite the increase in ATMs. As with the segregated-mode and mixed-mode scenarios, this reduction reflects the phase-out of older noisier aircraft types within the fleet. As in 2020 the MDL operating-mode results in slightly smaller contour areas than for MLD or the 'alternating' mode option, but again as in 2020, results in a slightly higher population impact, but compared with 2002, the population inside the 57dBA L_{eq} contour area has reduced by almost 20 percent.

3.8 Sensitivity Assessment

3.8.1 Past studies such as RUCATSE and SERAS, established the principle of plotting the 54dBA L_{eq} contour as a sensitivity test on the main assessment. This allows the contour area and population exposed to be assessed and identify if the trends between two cases are similar to those found for the 57dBA L_{eq} contour. If the trends are significantly different, it may indicate that one of the scenarios being compared is particularly sensitive to contour area and/or population changes. **Tables 3.12 to 3.22** tabulate the 54dBA L_{eq} contour areas, populations and household counts estimated for the scenarios presented in sections 3.1 to 3.7. The corresponding contours are illustrated in **Figures 3.14 to 3.24**.

Table 3.12: 2002 461,000 ATMs standard-mode contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	235.7	561.5	249.0

Table 3.13: 2015 480,000 ATMs base case noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	217.3	633.6	281.6

Table 3.14: 2015 540,000 ATMs mixed-mode noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	231.6	756.5	339.7

Table 3.15: 2020 615,000 ATMs with a third runway (option MLD) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	239.4	702.4	315.6

Table 3.16: 2020 670,000 ATMs with a third runway (option MDL) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	222.3	607.8	266.6

Table 3.17: 2020 605,000 ATMs with a third runway (alternating) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	230.2	614.9	270.5

Table 3.18: 2030 480,000 ATMs base case noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	138.8	345.7	148.2

Table 3.19: 2030 540,000 ATMs mixed-mode noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	161.0	424.8	186.6

Table 3.20: 2030 702,000 ATMs with a third runway (option MLD) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	207.8	593.0	265.0

Table 3.21: 2030 702,000 ATMs with a third runway (option MDL) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	179.9	445.8	192.9

Table 3.22: 2030 702,000 ATMs with a third runway (alternating) - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 54	202.4	534.6	233.6

3.8.2 The 2015 segregated-mode (480,000 ATMs) contour is forecast to be smaller than in 2002 (-8%), but the population enclosed is forecast to rise by 13 percent. This is due to the changing shape of the noise contours. A large part of the 54dBA L_{eq} noise contour area reduction in 2015 is to the south-west of the airport over Windsor Great Park, whereas the contour expands to the east along the southern runway in the densely populated areas of west London. It should be noted, however, that part of this population change is due to the unequal runway usage in 2002, with a smaller proportion of arrivals using the southern runway.

3.8.3 Although the 54dBA L_{eq} contour area with mixed-mode in 2015 is forecast to be smaller than 2002, the population enclosed is forecast to be significantly higher. This is due to significant expansion of the contour over west and south London, over Feltham, Twickenham and Slough, whereas the contour has contracted over the sparsely populated area west of Windsor Forest.

3.8.4 For the scenarios with a third runway in 2020, the populations inside the 54dBA L_{eq} contour are all less than for mixed-mode in 2015 and for two of the three scenarios (MDL and ‘alternating’) they are less than segregated-mode in 2015.

3.8.5 With the exception of the third runway scenario in 2030 operated as MLD, all scenarios in 2030 result in fewer people within the 54dBA L_{eq} contour than in 2002.

3.9 Summary

3.9.1 Under segregated-mode scenarios (limited to 480,000 ATMs), the contour area is predicted to decrease slightly by 2015 relative to 2002 and then decrease significantly in area by 2030, due to the phase-out of older, noisier aircraft types and the introduction of newer, quieter aircraft types.

3.9.2 Under mixed-mode scenarios, the contour area is predicted to decrease slightly by 2015 relative to 2002, thereby meeting the Air Transport White Paper requirement, but is predicted to be larger than it would be in 2015, were the current planning conditions retained.

3.9.3 Under scenarios with a third runway, the noise assessment suggests that full capacity of a third runway would not be achievable by 2020. In order to meet the White Paper requirement, movements would need to be around 605,000 ATMs with the alternating option. However, by 2030 the progressive retirement and replacement of the fleet with newer and quieter aircraft types would allow full capacity of the three runways to be realised, whilst meeting the White Paper requirement. Although the overall contour area is predicted to be considerably below that in 2002, the operation of a third runway would lead to areas with significantly higher noise exposure levels than in 2002, principally in areas close to the third runway, but also elsewhere due to the airspace design required to support a third runway. Conversely, in other areas, noise levels are reduced significantly relative to 2002.

4 Difference Contours

4.1 Introduction

4.1.1 A number of scenarios presented in section 3 result in significant changes in noise exposure. Whilst by comparing pairs of figures and interpolating between the 3dB spaced contours it is possible to determine the noise exposure change in particular areas, it is easier to visualise such comparisons in the form of difference contours.

4.1.2 Difference contours are just that. They represent the numeric difference in noise exposure level between two scenarios. The underlying noise calculation grids for two scenarios are first subtracted. Then contours are plotted to illustrate areas of constant noise difference. For all the difference contours in this section, the baseline year was 2002, as defined in the Airport Transport White Paper. In theory, differences can occur at any absolute noise exposure level. However, presenting changes in contour level at very low exposures would have little meaning, thus the difference calculation needs to be cut off at some point. For this analysis the difference calculation was cut off at 57dBA L_{eq}. The difference contours are presented as recommended in CAP 725 (Ref 11), covering the contours: -9, -6, -3, -2, -1, +1, +2, +3, +6 and +9dB. For each contour, the area covered and the total enclosed population and number of households is reported. Example difference contours are also presented in graphical format, using colour shading to illustrate areas where levels either increase or decrease.

4.2 Assessment

4.2.1 **Tables 4.1** to **4.10** respectively present noise difference contour areas, population and household counts for the scenarios presented in section 3 relative to noise exposure in 2002.

4.2.2 **Table 4.1** shows that most areas are expected to experience a decrease in noise exposure for the 2015 base case scenario compared with 2002. However, table 4.1 shows some areas will experience an increase. This is entirely due to the unequal usage of the two runways in 2002 due to maintenance work that resulted in more arrivals using the northern runway and more departures using the southern runway. By 2030 no areas are predicted to experience an increase for the base case scenario (Table 4.6).

4.2.3 **Table 4.2** shows the difference contour areas, populations and household counts for the 2015 540,000 ATMs mixed-mode scenario. Due to the different airspace design required for mixed-mode operation, some areas are likely to experience increases of over +3dB, but less than +6dB, whilst some areas are likely to experience decreases of more than 3dB. Overall, almost the same numbers of people are predicted to experience an increase of more than 1dB as those predicted to experience a decrease of more than 1dB. By 2030 (Table 4.7) less than 1,000 people are predicted to experience more noise than in 2002. In contrast almost 190,000 people are predicted to experience a decrease of at least 1dB relative to 2002 and for some a reduction of more than 6dB.

4.2.4 The scenarios associated with a third runway (**Tables 4.3, 4.4 & 4.5 in 2020 and 4.8, 4.9 & 4.10 in 2030**) result in significant changes to departure flight paths as well as the introduction of new flight paths. Both effects result in substantial changes in noise exposure, in some areas predicted to reduce by more than 9dB, whilst increasing by more than 9dB in other areas. Most populations experience more modest changes, with the majority experiencing a reduction in noise exposure. By 2030, despite the overall contour areas decreasing significantly relative to 2002, some areas still experience larger increases in noise exposure level compared with 2002.

4.2.5 In order to help illustrate the noise difference tables, examples are provided in **Figures 4.1** and **4.2** for the 2015 mixed-mode and 2030 R3 'alternating mode' scenarios respectively. The diagrams are not necessarily intuitive due to the unequal runway usage in 2002. It is for this reason that figures are not presented for the segregated-mode scenarios.

4.2.6 Figure 4.1 shows several areas where noise exposure levels increase or decrease. The blue shaded areas highlight regions where noise exposure is forecast to decrease relative to 2002, whereas red shaded areas highlight regions where noise exposure is forecast to increase relative to 2002.

4.2.7 There are three main reasons behind the noise levels changes illustrated in Figure 4.1. First, changes are forecast to occur due to the unequal runway usage in 2002. In that year 64% of arrivals used the northern runway, with 36% using the southern runway. Because more arrivals used the northern runway in 2002, even with the introduction of mixed-mode operations, noise levels are predicted to decrease, whereas for the southern runway, noise levels are predicted to increase.

4.2.8 Secondly, noise level changes are forecast to occur due to changes to the departure flight paths associated with the airspace design required for mixed-mode (as presented in Figure 2.4). This accounts for the darker red area (+3 to +6dB increase) around south Hounslow and the red areas around Harlington, Cranford and Osterley Park.

4.2.9 Finally, noise level changes are forecast to occur due to changes in numbers of movements and changes in the types of aircraft operated. The blue areas around Windsor Great Park are due to changes in fleet mix on the Compton (CPT) and Southampton (SAM) departure routes. The red area near Egham is due to an increase in the numbers of movements on the Dover (DVR) departure route, along with a reduction in flight path dispersion along the route.

4.2.10 Figure 4.2 shows the corresponding noise difference contours for 2030 with a third runway (main runways operated with alternation). Flight paths associated with a third runway result in large red areas showing noise level increases north of the airport extending towards Brentford to the east and over Richings Park and Langley Park to the west. The small red area to the southwest results from a realignment of departure routes that would be required following the introduction of a third runway. The large blue area showing noise level reductions is primarily due to fleet mix changes – the introduction of newer, quieter types and the phase-out of older noisier aircraft types.

Table 4.1: 2015 480,000 ATMs base case relative to 2002

Contour	Area (km²)	Populations (000s)	Households (000s)
<-9	0.0	0.0	0.0
<-6	0.3	0.0	0.0
<-3	3.5	6.9	2.6
<-2	12.1	33.3	12.5
<-1	51.4	100.7	41.1
>+1	11.1	45.3	20.8
>+2	0.5	1.7	0.7
>+3	-	-	-
>+6	-	-	-
>+9	-	-	-

Table 4.2: 2015 540,000 ATMs mixed-mode relative to 2002

Contour	Area (km²)	Populations (000s)	Households (000s)
<-9	0.0	0.0	0.0
<-6	0.1	0.0	0.0
<-3	12.0	20.5	8.2
<-2	27.9	41.3	16.5
<-1	54.9	96.3	39.2
>+1	33.5	97.3	43.5
>+2	16.3	54.2	24.3
>+3	4.4	10.2	4.5
>+6	-	-	
>+9	-	-	

Table 4.3: 2020 615,000 ATMs R3 MLD relative to 2002

Contour	Area (km²)	Populations (000s)	Households (000s)
<-9	11.2	24.4	10.0
<-6	35.3	55.5	22.5
<-3	55.7	97.5	40.7
<-2	66.1	131.5	53.9
<-1	78.3	161.2	66.1
>+1	54.8	79.1	32.5
>+2	45.2	63.0	26.0
>+3	39.4	51.7	21.1
>+6	23.8	34.2	13.5
>+9	16.5	19.8	7.8

Table 4.4: 2020 670,000 ATMs R3 MDL relative to 2002

Contour	Area (km^2)	Populations (000s)	Households (000s)
<-9	3.8	3.3	1.4
<-6	21.1	40.9	17.2
<-3	49.5	109.7	46.4
<-2	65.2	133.5	56.0
<-1	81.1	156.1	65.5
>+1	59.5	147.6	63.2
>+2	48.0	116.4	49.7
>+3	37.2	78.1	32.7
>+6	24.8	43.3	17.2
>+9	19.6	25.5	9.9

Table 4.5: 2020 605,000 ATMs R3 Alternating relative to 2002

Contour	Area (km^2)	Populations (000s)	Households (000s)
<-9	0.0	0.0	0.0
<-6	1.1	1.9	0.7
<-3	43.9	74.7	30.4
<-2	72.6	134.4	55.8
<-1	94.0	186.4	77.3
>+1	40.5	55.4	22.2
>+2	36.8	51.5	20.5
>+3	32.0	47.5	18.9
>+6	21.2	36.8	14.6
>+9	16.7	20.8	8.2

Table 4.6: 2030 480,000 ATMs base case relative to 2002

Contour	Area (km^2)	Populations (000s)	Households (000s)
<-9	0.2	0.0	0.0
<-6	1.8	1.4	0.5
<-3	62.5	113.4	46.6
<-2	102.4	192.1	79.2
<-1	116.4	228.1	94.7
>+1	-	-	-
>+2	-	-	-
>+3	-	-	-
>+6	-	-	-
>+9	-	-	-

Table 4.7: 2030 540,000 ATMs mixed-mode relative to 2002

Contour	Area (km²)	Populations (000s)	Households (000s)
<-9	-	-	-
<-6	1.1	2.1	0.8
<-3	44.4	72.5	29.1
<-2	76.3	147.4	61.4
<-1	99.1	189.5	78.3
>+1	0.8	0.9	0.4
>+2	-	-	-
>+3	-	-	-
>+6	-	-	-
>+9	-	-	-

Table 4.8: 2030 702,000 ATMs R3 MLD relative to 2002

Contour	Area (km²)	Populations (000s)	Households (000s)
<-9	14.7	31.2	12.9
<-6	40.3	63.3	26.0
<-3	61.0	103.9	43.6
<-2	73.4	139.4	57.2
<-1	88.2	178.6	73.6
>+1	39.3	48.2	19.6
>+2	34.5	39.9	15.9
>+3	30.4	35.9	14.2
>+6	17.1	22.7	8.8
>+9	13.9	12.9	5.1

Table 4.9: 2030 702,000 ATMs R3 MDL relative to 2002

Contour	Area (km²)	Populations (000s)	Households (000s)
<-9	7.7	10.1	4.3
<-6	30.4	62.9	26.2
<-3	69.4	141.3	59.1
<-2	83.7	159.5	67.0
<-1	93.5	174.2	72.8
>+1	41.0	100.8	42.8
>+2	32.3	68.8	29.0
>+3	24.0	39.0	15.5
>+6	18.5	27.5	10.8
>+9	14.7	14.8	5.8

Table 4.10: 2030 702,000 ATMs R3 Alternating relative to 2002

Contour	Area (km²)	Populations (000s)	Households (000s)
<-9	0.1	0.0	0.0
<-6	4.1	10.7	4.4
<-3	60.4	96.6	39.4
<-2	85.6	162.2	67.5
<-1	102.0	203.3	84.2
>+1	32.7	38.6	15.1
>+2	29.2	35.9	14.0
>+3	24.7	32.9	12.8
>+6	17.5	23.3	9.0
>+9	14.3	13.9	5.4

5 Changes to the Cranford Agreement and Westerly Preference

5.1 Review of the Cranford Agreement

5.1.1 The Cranford agreement is an undertaking dating back to the 1950s that aims to avoid easterly departures from the northern runway (09L) over Cranford whenever possible. Until the main runways were extended westward in the 1960s, Cranford was the nearest residential area to the airport at that time. It is not a written agreement, but is understood to have been a 'best endeavours' undertaking given at a public meeting in 1952. The main effect of the restriction is to only allow take-offs from the southern runway (09R) (whenever possible) during easterly operations, which in turn means that most easterly arrivals must fly over Windsor and Poyle to use the northern runway (09L). In common with the westerly preference arrangements, any change to the Cranford agreement would be likely to have an effect on the level or distribution of noise in the vicinity of the airport; therefore, changes may not be made without the prior approval of the Secretary of State.

5.2 Assessment

5.2.1 Daytime L_{eq} noise contours were generated in the same way as for the base case assessment, except during easterly operation the traffic was split 50/50 between the northern and southern runways, such that during the day half of the departures operated from runway 09L and half from runway 09R and likewise for the arrival operations. Mean departure tracks for runway 09L were derived from radar data for 2005, during which time a limited number of departures used runway 09L due to runway maintenance. **Table 5.1** presents the 16-hour L_{eq} noise contour areas, populations and household counts, for this scenario. The corresponding noise contours are shown in **Figure 5.1**.

Table 5.1: 2015 480,000 ATMs base case without the Cranford Agreement - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	120.1	251.4	105.8
> 60	65.7	106.8	42.7
> 63	38.7	53.7	21.0
> 66	23.0	17.7	6.8
> 69	11.9	4.1	1.6
> 72	6.5	0.8	0.3

5.2.2 Comparing the contours in Figure 5.1 with those for the same scenario with the Cranford agreement (Figure 3.2), shows that to the east of the airport the 57dBA L_{eq} contour area moves north covering more of Harlington and Heston, noise levels in some areas increasing by more than 3dB, this being associated with the introduction of easterly departures on the northern runway. To the southeast of the airport, however, the contours contract, due to the removal of half of the departure operations from the southern runway. Around Hounslow Heath noise exposure levels reduce by approximately 1-1.5dB.

5.2.3 To the west of the airport, the transfer of half of the arrival operations from the northern to the southern runway during easterly operations, reduces noise exposure in the vicinity of Windsor, whilst increasing noise exposure to the south over Old Windsor.

5.2.4 The changes relative to the 2015 480,000 ATMs base case assuming the Cranford agreement remains in place (Table 3.2) are presented in **Table 5.2**. Contour areas at all levels except 69 and 72dBA L_{eq} are seen to increase slightly due to the re-distribution of both departure and arrival movements over two runways during easterly operation.

5.2.5 Overall the changes in population exposed within various contours are relatively small. Table 5.2 does, however, illustrate that one of the effects of removing the Cranford agreement would be for it to reduce the number of people exposed further away from the airport, whilst near to the airport, where noise exposure levels are already higher (compared with further-out locations) the number of people exposed is predicted to increase. This differential change is due to the shape of the contours changing and also due to the non-homogenous population distribution around Heathrow, where small changes in contour area or shape may result in disproportionate changes in population exposed.

Table 5.2: 2015 480,000 ATMs base case without the Cranford Agreement – change relative to with Cranford Agreement

Leq (dBA)	Change in area (km²)	Change in population (000s)	Change in households (000s)
> 57	+0.3	-10.5	-4.9
> 60	+0.7	+1.5	+0.3
> 63	+0.7	+3.3	+1.1
> 66	+0.2	+2.6	+1.0
> 69	-0.1	+0.6	+0.2
> 72	-0.0	-0.1	-0.1

5.2.6 **Table 5.3** presents corresponding data for the forecast year 2030 without the Cranford Agreement. The associated noise contours are plotted in **Figure 5.2**.

5.2.7 The relative effects in terms of contour shape illustrated in Figure 5.2 (compared with Figure 3.9), are essentially similar to those in 2015 (i.e. Figure 5.1 vs Figure 3.2), except that the smaller contours associated with the changing fleet mix, result in the effects of removing the Cranford agreement being less apparent.

Table 5.3: 2030 480,000 ATMs base case without the Cranford Agreement - noise contour areas, populations and household counts

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	77.6	140.1	57.6
> 60	44.6	69.2	27.2
> 63	26.8	26.1	10.2
> 66	14.7	7.1	2.7
> 69	7.6	1.9	0.7
> 72	4.2	0.0	0.0

5.2.8 The changes relative to the 2030 480,000 ATMs base case assuming the Cranford Agreement remains in place (Table 3.7) are presented in **Table 5.4**. Contour areas for the 57, 60 and 63dBA L_{eq} contours are seen to increase slightly due to the re-distribution of both departure and arrival movements over two runways during easterly operation, whilst the area for the 66dBA L_{eq} contour decreases slightly. The effects are similar to those predicted for 2015, with the population exposed inside the 57dBA L_{eq} contours failing slightly, whilst increasing for the other contours.

Table 5.4: 2030 480,000 ATMs base case without the Cranford Agreement - change relative to with Cranford Agreement

Leq (dBA)	Change in area (km²)	Change in population (000s)	Change in households (000s)
> 57	+0.6	-2.1	-1.4
> 60	+0.3	+2.9	+1.0
> 63	+0.4	+1.7	+0.7
> 66	-0.1	+0.4	+0.2
> 69	-0.0	+0.4	+0.1
> 72	+0.0	+0.0	+0.0

5.3 Review of westerly preference

5.3.1 Normal practice requires that aircraft take off and land into wind. This was particularly important in the earlier days of aviation when propeller aircraft tended to operate at relatively low speeds and safety considerations required that all take-offs and landings were operated wherever possible directly into wind. Since those times, aircraft design and performance have improved such that operating directly into wind is no longer a requirement for modern jet transport aircraft which are often certificated to operate during take-off and landing with substantial crosswinds and/or tailwinds. This capability to operate routinely in such conditions has allowed airport operators some flexibility in the choice of runway direction, the desire often being to operate in the direction that mitigates the adverse noise effects of aviation. However, safety factors dictate that arranging takeoffs and landings into a headwind remains the preferred choice.

5.3.2 A ‘westerly preference' has been in operation at London Heathrow since 1962 as a noise mitigation measure. The preference enables westerly operations (i.e. arriving aircraft to approach Heathrow from the east over London and take-offs to the west over Berkshire) to continue when there is a light easterly following (tailwind) wind up to 5kts, providing that the runways are dry and any cross-wind does not exceed 12kts (Ref 12). Subsequently, ICAO published criteria for the use of preferential runways (Ref 13). The criteria are similar to those applied at London Heathrow, except that the crosswind limit is less restrictive with a maximum value of 15kts. Thus, the application of westerly preference at London Heathrow is fully compliant with international recommended practice.

5.3.3 The westerly preference procedure was introduced because take-off noise was the dominant aircraft noise issue at London Heathrow at the time. Maintaining westerly operations in this way reduces the need for aircraft to depart in an easterly direction over the densely populated areas of Hounslow, Ealing, Twickenham, etc. The relatively sparsely populated areas to the west of the airport allow the Noise Preferential Routes to pass between the main built-up areas. The operation of westerly preference forms an established part of the airspace arrangements that apply at Heathrow. A proposal to modify or abandon it would be likely to have an effect on the level or distribution of noise in the vicinity of the airport, therefore changes may not be made without the prior approval of the Secretary of State.

5.4 Modal split with easterly preference

5.4.1 The purpose of this study was to assess the current use of Heathrow's runways and quantify the changes in noise distribution in the vicinity of the airport associated with one of the following operational conditions, either with or without the Cranford agreement:

i) Retain a westerly preference at London Heathrow: aircraft operate in a westerly direction provided the westerly component of the tailwind does not exceed 5kts, the crosswind does not exceed 12kts and the runway surface remains dry;

ii) Replace westerly preference with an easterly preference at Heathrow: aircraft operate in an easterly direction provided the easterly component of the tailwind does not exceed 5kts, the crosswind does not exceed 12kts and the runway surface remains dry;

5.4.2 Although a 'no-preference' scenario was considered early on, operating such an arrangement potentially raises issues about how runway direction changes would be managed (potentially leading to a greater number of changes), thus the assessment was not taken forward. In practice, results would be expected to lie between the westerly and easterly preference scenarios presented.

5.4.3 The modal split, the split between westerly and easterly operations between mid-June and mid-September, is determined every year as part of the generation of annual Heathrow airport noise exposure contours. Since 1995 'standard' mode contours have been generated representing the long-term 20-year average modal split for Heathrow. Over the twenty years to 2006, the long-term average modal-split was 76 percent westerly operations and 24% easterly operations.

5.4.4 In order to predict the theoretical modal-split associated with an easterly preference an analysis was undertaken of six years of hourly meteorological data for the years 2000-2005. Although some data was available for earlier years, there was some concern over the accuracy of the data collected, thus it was felt that a smaller sample of years of more robust data was appropriate. The analysis sought to predict the change in modal split across the six years were the westerly preference to be replaced with an easterly preference. This change in modal split was then applied to the rolling 20-year average modal split traditionally used for noise contouring. This approach limited the potential for the smaller six-year sample of meteorological data to skew the overall analysis.

5.4.5 The percentage of easterly and westerly operations under each preference scenario are shown in **Table 5.5**. The analysis concluded that there would be a large shift in the long-term modal-split were the airport to move to an easterly preference, with the proportion of easterly operations likely to exceed westerly operations over the long term. Year to year variation would likely result in individual years with even higher proportions of easterly operations and some with less.

Table 5.5: Percentage of easterly and westerly operations for an average summer day as a function of operating mode

Operating Preference	% East	% West
Westerly preference	24	76
Easterly preference	55	45

5.4.6 Part of the explanation for a large shift in modal-split results from the typical wind patterns affecting Heathrow airport and the southeast of the UK. The analysis confirmed that the prevailing winds affecting the airport are south-westerly winds. Currently a westerly preference means that aircraft takeoff to the west during periods of lightly easterly winds, and an easterly preference would reverse this such that aircraft would takeoff to the east during light westerly winds. The analysis showed that periods of light westerly winds are approximately twice as common as light easterly winds, thus an easterly preference would be applied operationally for twice the amount of time as westerly preference is applied today. This explains the large switch from westerly operations.

5.4.7 It should be noted that taking off with a tail wind affects aircraft climb performance and thus also has a bearing on noise in the immediate vicinity of the airport. It is for this reason that an allowance is made for higher noise levels during tailwind takeoffs at the fixed noise monitors. This assessment has simply considered the effects of runway direction and not considered any consequential effects on noise from changes to aircraft performance as the effects would be second order to those associated with modal-split, but would need to be considered at a later stage were serious consideration given to adopting an easterly preference.

5.5 Assessment of an easterly preference

5.5.1 The following section presents tables of contour areas, populations and household counts for all the scenarios covered in section 3 and for the two scenarios without the Cranford agreement presented in section 5.2. Because of the number of scenarios, contours are only presented diagrammatically for selected cases.

5.5.2 **Table 5.6** shows the noise contour areas, populations and household counts for the 2015 480,000 ATMs base case assuming an easterly preference. The associated contours are shown diagrammatically in **Figure 5.3**. The case compares directly with the westerly preference case presented in Table 3.2. The contour area, population and household count differences are shown in **Table 5.7**.

Table 5.6: 2015 480,000 ATMs base case noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	115.5	266.7	111.0
> 60	62.5	121.6	49.0
> 63	37.2	50.9	20.0
> 66	22.1	15.8	6.1
> 69	11.4	2.5	1.0
> 72	6.4	0.6	0.3

Table 5.7: 2015 480,000 ATMs base case noise contours– changes relative to westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-4.3	+4.8	+0.3
> 60	-2.5	+16.4	+6.7
> 63	-0.8	+0.5	+0.1
> 66	-0.8	+0.7	+0.4
> 69	-0.7	-1.0	-0.4
> 72	-0.2	-0.3	-0.1

5.5.3 Contour areas are seen to decrease slightly with the introduction of an easterly preference. This is most likely due to the layout of easterly noise preferential departure routes, which to avoid the major populated areas turn away more rapidly than their corresponding westerly departure routes (see Figure 2.3). Despite the contour area reductions, populations within the contours increase with the exception of the 69 and 72dBA L_{eq} contours. The findings suggest that for the base case 480,000 ATMs scenario, a westerly preference reduces noise effects compared with an easterly preference.

5.5.4 **Table 5.8** shows the contour areas, populations and household counts for the 2015 480,000 ATMs scenario without the Cranford agreement and with an easterly preference. The associated contours are shown diagrammatically in **Figure 5.4**. The corresponding westerly preference scenario was presented in Table 3.2; the changes between the two scenarios are shown in **Table 5.9**.

Table 5.8: 2015 480,000 ATMs base case noise contours without Cranford Agreement and with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	117.4	265.4	110.0
> 60	64.1	115.8	45.9
> 63	38.4	55.2	21.5
> 66	23.7	23.0	8.8
> 69	11.6	3.8	1.4
> 72	6.3	0.6	0.2

Table 5.9: 2015 480,000 ATMs base case noise contours without Cranford Agreement and with an easterly preference – changes relative to westerly preference with the Cranford agreement in place

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-2.4	+3.5	-0.6
> 60	-1.0	+10.5	+3.6
> 63	+0.5	+4.7	+1.6
> 66	+0.8	+7.9	+3.0
> 69	-0.5	+0.3	+0.0
> 72	-0.2	-0.3	-0.1

5.5.5 Contour area changes are relatively small since the movements used remain unchanged, the shape of the contour itself tending to have only a second order effect on contour area. Populations increase slightly for all contours except the 72dBA L_{eq} contour, increasing by 7,900 (+53%) for the 66dBA L_{eq} contour. This compares with an increase of 2,600 (+17%) (Table 5.2) when considering only the effect of the removal of the Cranford agreement. This clearly illustrates that close in, the effects of removing the Cranford agreement would be exacerbated further with the introduction of an easterly preference.

5.5.6 **Table 5.10** shows the noise contour areas, populations and household counts for 2015 mixed-mode (540,000 ATMs) with an easterly preference. The associated contours are shown diagrammatically in **Figure 5.5**. The changes relative to a westerly preference are highlighted in **Table 5.11**. Some contour areas increase slightly whilst other decrease, with no apparent trend. This suggested there is some re-distribution of noise associated with the change of operating preference. However, the populations exposed increase, most notably for the 57dBA L_{eq} contour, where the population increases by 15,100 (5.5%). Although the contours contract under the westerly approach paths around Barnes, the contours expand under the easterly approach paths over Windsor and to the east of the airport over densely populated areas of Twickenham and south Ealing, accounting for the population increase.

Table 5.10: 2015 540,000 ATMs mixed-mode noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	124.5	289.1	121.8
> 60	69.0	128.9	51.8
> 63	40.7	66.8	26.1
> 66	23.6	24.1	9.1
> 69	12.1	5.3	2.0
> 72	6.5	1.0	0.4

Table 5.11: 2015 540,000 ATMs mixed-mode noise contours with an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-1.0	+15.1	+4.7
> 60	-2.0	+2.2	+0.4
> 63	-0.2	+6.6	+2.4
> 66	+0.3	+3.6	+1.2
> 69	-0.2	+0.6	+0.2
> 72	-0.1	-0.2	-0.1

5.5.7 **Table 5.12** shows the noise contour areas, populations and household counts for the 2020 R3 MLD scenario (615,000 ATMs) with an easterly preference. The changes relative to a westerly preference are highlighted in **Table 5.13**. The 57dBA L_{eq} contour area shows a decrease (-2.5%) whereas the 60 and 63dBA L_{eq} contour areas show an increase of 11.5% and 19% respectively. For this scenario, moving to an easterly preference is seen to reduce approach noise over west London (Barnes and Brentford), whilst increasing approach noise over Windsor. Departure noise reduces over Windsor Great Park and Langley Park, whilst increasing over Southall and Twickenham.

5.5.8 In terms of changes in population exposed, although the 57dBA L_{eq} contour area reduces, the change in shape of the noise contours increases the population exposed by 28,100 (+12%). For the other contour levels the population increases are even more significant due to the combination of increasing contour area and changing contour shape. For example the populations within the 60, 63 and 66dBA L_{eq} contours are predicted to increase by 68%, 111% and 129% respectively. These results illustrate that the R3 MLD option is very sensitive to the proportion of westerly and easterly operations, which in itself implies that the impact during easterly day operations must be disproportionately higher than for a westerly day operation. This is actually apparent from Figure 3.5. An easterly preference will extend the contours over densely populated parts of west London, whilst contracting the contours in the relatively sparsely populated areas to the west of the airport.

Table 5.12: 2020 615,000 ATMs R3 MLD noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	123.3	262.7	106.2
> 60	74.8	141.7	55.9
> 63	43.6	66.8	26.0
> 66	21.8	25.9	10.1
> 69	11.3	6.1	2.5
> 72	6.1	0.4	0.2

Table 5.13: 2020 615,000 ATMs R3 MLD noise contours with an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-3.2	+28.1	+8.9
> 60	+8.7	+57.3	+22.6
> 63	+7.0	+35.2	+13.7
> 66	+2.4	+14.6	+5.8
> 69	+0.9	+2.2	+1.0
> 72	+0.3	-1.0	-0.3

5.5.9 **Table 5.14** shows the contour areas, populations and household counts for the 2020 R3 MDL scenario (670,000 ATMs). The changes relative to a westerly preference are highlighted in **Table 5.15**. For this scenario and airspace design, the contour areas are seen to decrease upon moving to an easterly preference. Changes to the shape of the contour still result in a small increase in the population inside the 57dBA L_{eq} contour, but populations reduce for most other contour levels, an effect unique to this scenario. Although an easterly preference increases the number of departures taking off to the east over Southall and Twickenham, this is more than offset by the increase in easterly arrivals to the southern runway, which for this option pass over the sparsely populated areas of Windsor Great Park.

Table 5.14: 2020 670,000 ATMs R3 MDL noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	125.3	263.8	107.9
> 60	66.2	107.9	43.3
> 63	36.4	39.4	15.5
> 66	19.2	10.9	4.3
> 69	10.4	3.5	1.4
> 72	5.7	0.3	0.2

Table 5.15: 2020 670,000 ATMs R3 MDL noise contours with an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-1.6	+4.9	+0.4
> 60	-6.4	-14.6	-5.4
> 63	-5.7	-10.4	-4.5
> 66	-2.1	-6.5	-2.8
> 69	-1.0	+0.1	-0.2
> 72	-0.6	-0.5	-0.2

5.5.10 **Table 5.16** shows the contour areas, populations and household counts for the 2020 R3 Alternating scenario (605,000 ATMs). The changes relative to a westerly preference are highlighted in **Table 5.17.** As with all previous scenarios, except R3 MDL, the population exposed within each contour increases with an easterly preference. Although westerly arrival noise reduces, easterly arrival noise increases, with the 57dBA L_{eq} contour encompassing Windsor, and the easterly departure noise contours extending out towards Southall and Twickenham.

Table 5.16: 2020 605,000 ATMs R3 Alternating noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	123.3	262.7	106.2
> 60	74.8	141.7	55.9
> 63	43.6	66.8	26.0
> 66	21.8	25.9	10.1
> 69	11.3	6.1	2.5
> 72	6.1	0.4	0.2

Table 5.17: 2020 605,000 ATMs R3 Alternating noise contours with an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-3.4	+20.4	+6.5
> 60	+4.9	+40.2	+16.1
> 63	+3.8	+31.2	+12.0
> 66	+0.4	+16.4	+6.2
> 69	+0.2	+2.9	+1.2
> 72	+0.0	+0.1	+0.1

5.5.11 **Table 5.18** shows the contour areas, populations and household counts for the 2030 480,000 ATMs base case. The changes relative to a westerly preference are highlighted in **Table 5.19**. The smaller contours associated with this scenario result in it being much less sensitive to a switch to an easterly preference than predicted in 2015. The largest change occurs inside the 57dBA L_{eq} contour where population exposed rises by 11,100 (+8%). This is attributable to the easterly arrival contour extending out over Windsor, whilst one of the easterly departure lobes extends over the sparsely populated Osterly Park.

Table 5.18: 2030 480,000 ATMs noise contours with Cranford Agreement and an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	73.1	153.3	61.9
> 60	42.6	67.1	26.7
> 63	26.3	26.2	10.1
> 66	13.6	4.5	1.8
> 69	7.4	0.8	0.4
> 72	4.1	0.1	0.0

Table 5.19: 2030 480,000 ATMs noise contours with Cranford Agreement and an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-3.9	+11.1	+3.0
> 60	-1.7	+0.8	+0.5
> 63	-0.1	+1.8	+0.6
> 66	-1.2	-2.2	-0.8
> 69	-0.2	-0.8	-0.3
> 72	-0.0	+0.1	+0.0

5.5.12 **Table 5.20** shows the contour areas, populations and household counts for the 2030 base case (480,000 ATMs) without the Cranford agreement. The changes relative to a westerly preference are highlighted in **Table 5.21**. As with the preceding scenario, the 2030 segregated-mode scenario assuming the Cranford agreement is removed is much less sensitive to runway preference than in 2015. Although the westerly arrival contours contract, the easterly arrival contours extend over part of Windsor. Westerly departure contours contract around Hythe End and north-east of Eton, but easterly departure contours extend over north Heston and west Twickenham.

Table 5.20: 2030 480,000 ATMs noise contours without the Cranford Agreement and an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	74.9	146.0	58.5
> 60	43.8	71.0	27.9
> 63	27.5	30.3	11.7
> 66	14.1	6.8	2.6
> 69	7.4	1.7	0.6
> 72	4.1	0.0	0.0

Table 5.21: 2030 480,000 ATMs noise contours without the Cranford Agreement and an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-2.7	+5.9	+0.9
> 60	-0.7	+1.8	+0.7
> 63	+0.7	+4.2	+1.5
> 66	-0.7	-0.3	-0.1
> 69	-0.2	-0.2	-0.1
> 72	-0.1	+0.0	+0.0

5.5.13 **Table 5.22** shows the contour areas, populations and household counts for the 2030 mixed-mode scenario (540,000 ATMs). The changes relative to a westerly preference are highlighted in **Table 5.23**. As with the preceding 2030 scenarios, an easterly preference results in little overall change in populations affected, there is simply a trade-off between population centres east and west of the airport. A reduction in noise under the westerly approach path is compensated by an increase under the easterly arrival path taking Windsor inside the 57dBA L_{eq} contour. Reductions in westerly departure noise exposure over Slough and Englefield Green are compensated for by an increase in easterly departure noise over north Heston and Twickenham.

Table 5.22: 2030 540,000 ATMs noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	89.3	174.3	71.9
> 60	51.0	91.7	36.1
> 63	30.3	40.5	15.6
> 66	16.2	11.0	4.1
> 69	8.5	2.6	0.9
> 72	4.7	0.0	0.0

Table 5.23: 2030 540,000 ATMs noise contours with an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-0.6	-5.0	-4.7
> 60	-0.3	+2.7	+0.7
> 63	-0.1	-0.4	-0.3
> 66	-0.7	-1.0	-0.3
> 69	-0.2	-0.6	-0.3
> 72	-0.1	-0.0	-0.0

5.5.14 **Table 5.24** shows the contour areas, populations and household counts for the 2030 R3 MLD scenarios (702,000 ATMs). The changes relative to a westerly preference are highlighted in **Table 5.25**. For this scenario, a switch to an easterly preference is forecast to increase the population within the 57dBA L_{eq} contour area by just over 35,000 (+20%). This is because the contour contracts over Osterly Park, Langley Park and Windsor Great Park, whilst expanding over Windsor, Twickenham and Southall. Closer in to the airport, the effects of change of preference are less significant.

Table 5.24: 2030 702,000 ATMs R3 MLD noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	106.3	226.4	92.0
> 60	57.7	87.4	34.8
> 63	31.2	30.5	11.9
> 66	16.7	9.6	3.8
> 69	9.1	2.9	1.1
> 72	5.0	0.2	0.1

Table 5.25: 2030 702,000 ATMs R3 MLD noise contours with an easterly preference – changes relative to westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-3.1	+35.2	+13.2
> 60	+0.6	+19.7	+8.1
> 63	-0.4	+2.2	+1.0
> 66	-0.0	-1.5	-0.4
> 69	+0.0	-0.8	-0.2
> 72	-0.1	-0.9	-0.3

5.5.15 **Table 5.26** shows the contour areas, populations and household counts for the 2030 R3 MDL scenarios (702,000 ATMs). The changes relative to a westerly preference are highlighted in **Table 5.27**. The effect of an easterly preference on this scenario is similar to the previous (MLD) option, except that it results in a greater increase to the population within the 63dBA L_{eq} contour (+23%).

Table 5.26: 2030 702,000 ATMs R3 MDL noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	104.8	214.4	85.3
> 60	61.2	111.0	43.4
> 63	34.1	51.5	20.0
> 66	17.2	16.5	6.5
> 69	9.2	3.2	1.4
> 72	5.0	0.3	0.2

Table 5.27: 2030 702,000 ATMs R3 MDL noise contours with an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-0.8	+5.5	-0.3
> 60	+1.8	+20.6	+7.4
> 63	+0.6	+15.5	+5.5
> 66	+0.3	+4.6	+1.5
> 69	-0.0	+0.8	+0.2
> 72	-0.2	-0.2	-0.1

5.5.16 **Table 5.28** shows the contour areas, populations and household counts for the 2030 R3 Alternating scenario (702,000 ATMs). The associated contours are shown diagrammatically in **Figure 5.6**. The changes relative to a westerly preference are highlighted in **Table 5.29**. Again as for two previous R3 scenarios, a switch to an alternating preference is forecast to significantly increase the number of people exposed within the 57 and 60dBA L_{eq} contours.

Table 5.28: 2030 702,000 ATMs R3 Alternating noise contours with an easterly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	111.4	225.3	89.4
> 60	62.6	103.7	40.6
> 63	34.1	35.6	13.7
> 66	17.9	9.5	3.8
> 69	9.6	2.3	1.0
> 72	5.4	0.2	0.1

Table 5.29: 2030 702,000 ATMs R3 Alternating noise contours with an easterly preference – changes relative to a westerly preference

Leq (dBA)	Area (km²)	Population (000s)	Households (000s)
> 57	-1.5	+19.6	+5.0
> 60	+0.4	+17.2	+6.7
> 63	-0.1	+4.5	+1.5
> 66	-0.5	+1.4	+0.5
> 69	-0.2	-0.3	-0.1
> 72	-0.1	-0.0	-0.0

5.6 Summary

5.6.1 Removing the Cranford agreement is shown to result in a re-distribution of noise exposure to the west of the airport under the easterly arrival flight paths and also to the east of the airport under the easterly departure flight paths. Overall populations within the 57dBA L_{eq} contour are predicted to decrease due to the transfer of arrival operations away from Windsor onto the southern runway and its more sparsely populated arrival flight path. However, in higher noise exposure areas, populations are predicted to increase slightly, this being primarily due to increases in noise exposure around Heston and Cranford, offsetting reductions in north Feltham.

5.6.2 A switch to an easterly preference significantly increases the effects of removing the Cranford agreement, an entirely logical finding since both combine to increase noise exposure immediately east of the airport.

5.6.3 For all growth scenarios there is also a re-distribution of noise around the airport. However, for all but one scenario (R3 MDL in 2020), a switch to an easterly preference is seen to increase the population exposed within most contours, especially within the 57dBA L_{eq} contour. In all these cases, the primary reason is the greater population density east of the airport.

6 Airport Operations Diagrams

6.1 Introduction

6.1.1 For some of the scenarios presented in section 3 it is recognised that there are predicted to be significant changes in the patterns of flight paths far away from Heathrow airport. It must be stressed that at this stage, the precise location of flight paths associated with mixed-mode or a third runway are not known and thus the flight paths presented in this report must be considered as indicative. Close to the airport there will be some certainty over them, as the options for re-design are limited, but further away from the airport the flight paths are much less certain.

6.1.2 With such potential changes to the flight paths and airspace around Heathrow airport it is recognised that the noise contours presented in sections 3, 4 and 5 do not necessarily portray all the information that may be desired. One option may be to present noise contours at lower exposure levels. There is, however, significant uncertainty involved in the generation of noise contours at lower exposure levels, including a lack of reliable noise monitoring data as well as a need to more accurately portray aircraft lateral track dispersion. Both of these factors provide sufficient uncertainty that it may be difficult to compare scenarios.

6.1.3 It is also recognised that past UK and international social surveys show that at low noise exposure levels there is only a weak link between the actual exposure level and reported annoyance due to aircraft noise. It is possible that a number of factors such as visual intrusion and frequency of flights are as important as the noise exposure level itself.

6.1.4 In order to supplement the information provided in the form of noise contours, diagrams have been put together providing information on the flight paths and numbers of movements along these flight paths covering a much wider area. These diagrams have been named airport operations diagrams. As well as providing information on flight paths and average numbers of movements, the diagrams also provide information on the variation in movements between easterly and westerly operation and the likely respite (proportion of time with no movements).

6.2 Assessment

6.2.1 This section briefly describes eight airport operations diagrams.

a) 2002 segregated-mode departure and arrival diagrams **(Figures 6.1 & 6.2)**
b) 2015 with mixed-mode departure and arrival diagrams **(Figures 6.3 & 6.4)**
c) 2030 with a third runway (MLD) departure and arrival diagrams **(Figures 6.5 & 6.6)**
d) 2030 with a third runway (MDL) departure and arrival diagrams **(Figures 6.7 & 6.8)**

6.2.2 Note that diagrams for the alternating R3 option have not been generated since they are in effect a 50/50 mix of the MLD and MDL options. Merging these two diagrams results in far too complex a diagram.

6.2.3 For 2002, the departure diagram portrays the mean departure swathes and the associated dispersed flight tracks (green shaded areas) as flown in 2002. The nominal length of a noise preferential route is defined by a four percent climb gradient to 4,000ft above mean sea-level (amsl), however some current noise preferential routes (NPRs) are longer than others due to airspace constraints. Aircraft are permitted to be ‘vectored’ away from an NPR before they reach the end, once they have reached 4,000ft (amsl) and many aircraft do so, accounting for the green shaded areas that emerge from the sides of NPRs. For future cases the indicative NPRs and likely flight path dispersion are presented. For the mixed-mode and R3 scenarios, the lengths of the NPRs as presented are based on the current NPRs. Subsequent refinement of the airspace designs may result in the NPRs shortening, particularly in the case of NPRs for a third runway, which would likely be designated as high-performance and limited to certain aircraft types.

6.2.4 Arrival diagrams portray the likely arrival swathes from the holding stacks down to touchdown. These are coloured to illustrate three distinct height ranges (above airfield level): above 6,000ft, 6,000 to 3,000ft and 3,000ft to ground level.

6.2.5 Both arrival and departure diagrams present boxes to identify the actual (2002) or forecast number of aircraft movements on an arrival swathe or departure NPR. Information is provided on the number of movements for an average summer day (0700 to 2300), taking into account the different modes of operation, i.e. easterly or westerly operation. Information is provided on the daily range, that is, the number of operations on either an easterly or westerly day. The current long-term average at Heathrow is for 76 percent of movements to operate in a westerly flow, thus the maximum daily range for a westerly day is around 30 percent more than on average (on any westerly day the total number of movements is 1/0.76 times that of the average). In contrast, on average 24 percent of the time the airport operates in an easterly flow and here the daily range is around four times higher than on average (on any easterly day the total number of movements is 1/0.24 times that of the average). Information is also provided on the percentage of all departures or arrivals on a particular swathe or NPR and proportion of time with no operations. It should be noted that the numbers presented on the diagrams for the forecast cases are based on the inputs to the noise modelling process and whilst they represent a best estimate of future movements by route, they are subject to uncertainty.

6.2.6 Note that the movement information on the arrival diagrams is presented in terms of individual arrival swathes that join from the north or south. In the case of Figures 6.6 and 6.8, the arrival streams from the north and south merge to land on a single runway. Once the streams have merged, the total movements will represent the sum of the data presented in the information boxes for two separate streams.

6.2.7 **Figures 6.1 and 6.2** present the 2002 departure and arrival airport operations diagrams for Heathrow airport. As has been noted earlier in this document, runway usage was unequal in the summer of 2002 due to maintenance work, resulting in 65% of arrivals using the northern runway (during westerly operation).

6.2.8 **Figure 6.3** presents the indicative 2015 mixed-mode departure airport operations diagram for Heathrow airport. This diagram reflects the mixed-mode airspace design presented in figure 2.4. The most significant feature is that departure routes no longer cross, a requirement of independent runway operation. Thus, with the exception of the easterly Dover (DVR) and westerly Compton (CPT) departure routes, northbound departure routes operate from the northern runway and southbound routes operate from the southern runway. This will likely result in the realignment of some departure routes, most notably the 09R Dover (DVR) route.

6.2.9 **Figure 6.4** presents the indicative 2015 mixed-mode arrival airport operations diagram for Heathrow airport. As noted in paragraph 2.5.3, the ILS intercept has moved further out from the airport, which will result in new areas overflown. The longer light-green shaded area approaching the southern runway illustrates the region where aircraft are expected to be lower in order to provide the necessary vertical height separation between the two arrival streams approaching from the north and south.

6.2.10 **Figure 6.5** presents the indicative 2030 R3 MLD departure airport operations diagram for Heathrow airport. For this scenario and airspace design, the main runways would operate in a fixed segregated-mode with all departures using the southern runway (similar to current day easterly operation). The third runway would be operated in mixed-mode with both arrivals and departure operations throughout the day. In order to provide separation from a third runway, the easterly Brookmans Park (BPK) and Buzad (BUZ) departure routes, and westerly Brookmans Park (BPK) and Wobun (WOB) departure routes would need to extend further east and west from the ends of the runway.

6.2.11 **Figure 6.6** presents the indicative 2030 R3 MLD arrival airport operations diagram for Heathrow airport. Aircraft operating to the main runway would approach from the north and south. Aircraft would likely approach a third runway from the north only. For the approach paths to the main runways, the ILS intercept point would likely be extended further out than for mixed-mode operations.

6.2.12 **Figure 6.7** presents the indicative 2030 R3 MDL departure airport operations diagram for Heathrow airport. This scenario is similar to that shown in Figure 6.5, except that departure operations on the main runways would operate from the current northern runway only. The third runway would continue to be operated in mixed-mode.

6.2.13 **Figure 6.8** presents the indicative 2030 R3 MDL arrival airport operations diagram for Heathrow airport. This scenario is similar to that shown in Figure 6.6, except that the arrival operations on the main runways would operate to the southern runway only.

6.2.14 As already noted, it would be possible to operate a third runway and re-introduce alternation to the main runways. This would effectively mean that for half a day, the airport would as 'MLD' and then half as 'MDL' alternating on a weekly and daily arrangement as today. The effective numbers of operations on each swathe would then be half that presented on the 'MLD' diagram and half that on the 'MDL' diagram. Operations on a third runway are expected to be unaffected by the use of alternation on the main runways.

7 Night-time Considerations

7.1 The assessment presented in sections 3 through 6 has focused on daytime noise exposure since this will be primarily affected through the introduction of additional capacity.

7.2 There have been restrictions on night flights at Heathrow for many years. The restrictions have been reviewed about every five or six years. The current night noise restrictions regime began in October 2006 and will extend until March 2012. The current regime defines two periods, a night period from 2300 to 0700 and a night quota period from 2330 to 0600. Within the night period the noisiest types of aircraft (defined as QC/8 and above using the Quota Count scheme) may not be scheduled to take off or land. Additionally more stringent departure noise limits (compared to the daytime) apply in the shoulder hours 2300-2330 and 0600-0700.

7.3 Within the night quota period aircraft movements are heavily restricted and the types of aircraft that may be operated are restricted through the use of the Quota Count scheme. Any aircraft which has a quota count of 4 may not be scheduled to take off or land during the night quota period. The current night restrictions do *not* permit any additional movements to be added to the night quota period up to 2012 and define a noise abatement objective to limit the 6.5 hour 48 dBA L_{eq} contour area to 55 km^2 by 2012.

7.4 There is however some flexibility for additional movements to be accommodated within the shoulder periods (2300-2330 and 0600-0700), although 0600-0700 period in particular is at capacity or very near capacity at present.

7.5 Preliminary night forecasts (2300-0700) were provided by BAA for the same scenarios considered in section 3, for which the numbers of arrivals and departures are summarised in Table 7.1.

Table 7.1: Historical and forecast movements in the night period (2300-0700)

	2003	2006	2015	2015	2030
		segregated-mode		mixed-mode	R3
No. of arrivals	52	55	54	44	60
No. of departures	17	20	20	29	36
Total movements	69	75	74	73	96

7.6 Whilst noise contours were not generated from the historical and forecast movement data it is nonetheless useful to consider 7.1 in more detail. The 2015 segregated-mode forecasts are almost identical to historical data for 2006. This is actually not surprising since BAA, in developing the forecast, is cognisant of the present night restriction scheme which although runs to 2012, is unlikely to change significantly by 2015. What table 7.1 does not show is that the underlying forecast shows a significant move away from Boeing 747-400 operations, currently the single most dominant aircraft type at night, towards quieter Boeing 777-300, Airbus A340-600 and A380 aircraft.

7.7 Night-time operations during winter 2006 were significantly disrupted due to adverse weather, which may have affected the number of night-time operations. For context, information is also provided in table 7.1 for the year 2003. Movements in 2006 are slightly higher than in 2003, and this in part may be due to the adverse weather in winter 2006, but it does not in any way imply that 2006 is sufficiently atypical to preclude comparison with forecasts for 2015.

7.8 Although these forecasts are preliminary, the mixed-mode forecast in 2015 does not show any significant increase in overall movements rather a change in the mix of operations.

7.9 Whilst these preliminary forecasts indicate that the introduction of a third runway might provide the opportunity to increase ATMs in the night period, the underlying assumption is that these additional movements would be contained within the shoulder periods .The continuing phase out of older noisier aircraft types, including the complete phase out of the Boeing 747-400 by 2030 likely means that even with such movement growth, the night time contour area would be comparable to the current area, although it is recognised that more detailed analysis would need to be undertaken to verify this.

8 Conclusions

8.1 This report describes the results of an updated assessment of the noise exposure effects associated with the provision of additional capacity at Heathrow Airport. A range of scenarios has been assessed from a continuation of the present movement limit of 480,000 ATMs, to the introduction of mixed-mode operation in 2015 and the addition of a third runway in 2020. All scenarios have also been assessed in 2030.

8.2 In addition, an assessment has been made of the effects of removing the Cranford agreement on the segregated-mode scenarios. An assessment has also been undertaken of the effects of changing the present system of westerly preference, which increases the proportion of time the airport operates in a westerly flow.

8.3 As part of the assessment, a comprehensive review of the input data required for noise contour modelling has been undertaken. This included refining definitions of the noise characteristics of future aircraft types compared with previous assessments and the incorporation of airspace designs for mixed-mode and operation with a third runway, which whilst indicative and subject to more detailed design work, is far more representative of a likely operating situation than anything considered for previous assessments.

8.4 For each scenario, tables of contour areas, populations and household counts within each contour are provided, along with diagrams illustrating the shape and location of the noise contours. In addition noise difference contours have been generated quantifying the areas, populations and household counts subject to specific changes in noise exposure.

8.5 The main assessment has focused on how the 16 hour average summer day L_{eq} noise exposure contours compare with 2002, the baseline defined in the Air Transport White Paper and specifically how the scenarios compare against the White Paper commitment that the 57dBA L_{eq} contour area should not exceed the 127 km^2 that it covered in 2002.

8.6 The assessment has shown that mixed-mode operation providing for a total of 540,000 ATMs in 2015 could meet this limit. With regard to a possible third runway, the assessment has shown that full capacity (702,000 ATMs) may *not* be realised in 2020 without significant incentives to encourage airlines to replace the current large numbers of four-engined aircraft with a greater proportion of large twin-engined aircraft. However, by 2030 the maximum capacity forecast with a third runway could be accommodated. Whilst the overall noise contour area in 2030 with a third runway is forecast to be somewhat below the 2002 level, some areas would experience noise levels considerably higher than in 2002. Such effects may be mitigated as part of a future planning application.

8.7 It is recognised that for some, noise exposure contours are difficult to interpret and understand, and that further away from the airport, noise may be one of many factors affecting community annoyance. In addition, because the introduction of mixed-mode or a third runway may involve significant airspace changes, this assessment has also included airport operations diagrams, providing information on the indicative flight paths and likely numbers of movements on these flight paths.

8.8 Finally, a preliminary indication of possible night-time effects has been presented.

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13. “Noise Preferential Runways and Routes”, ICAO Procedures – Aircraft Operations (ICAO-PANS OPS) – ICAO Document 8168, Volume 1, Section 7, Chapter 2,Fifth Edition 2006.

Figure 2.1: Progress in source noise reduction over time

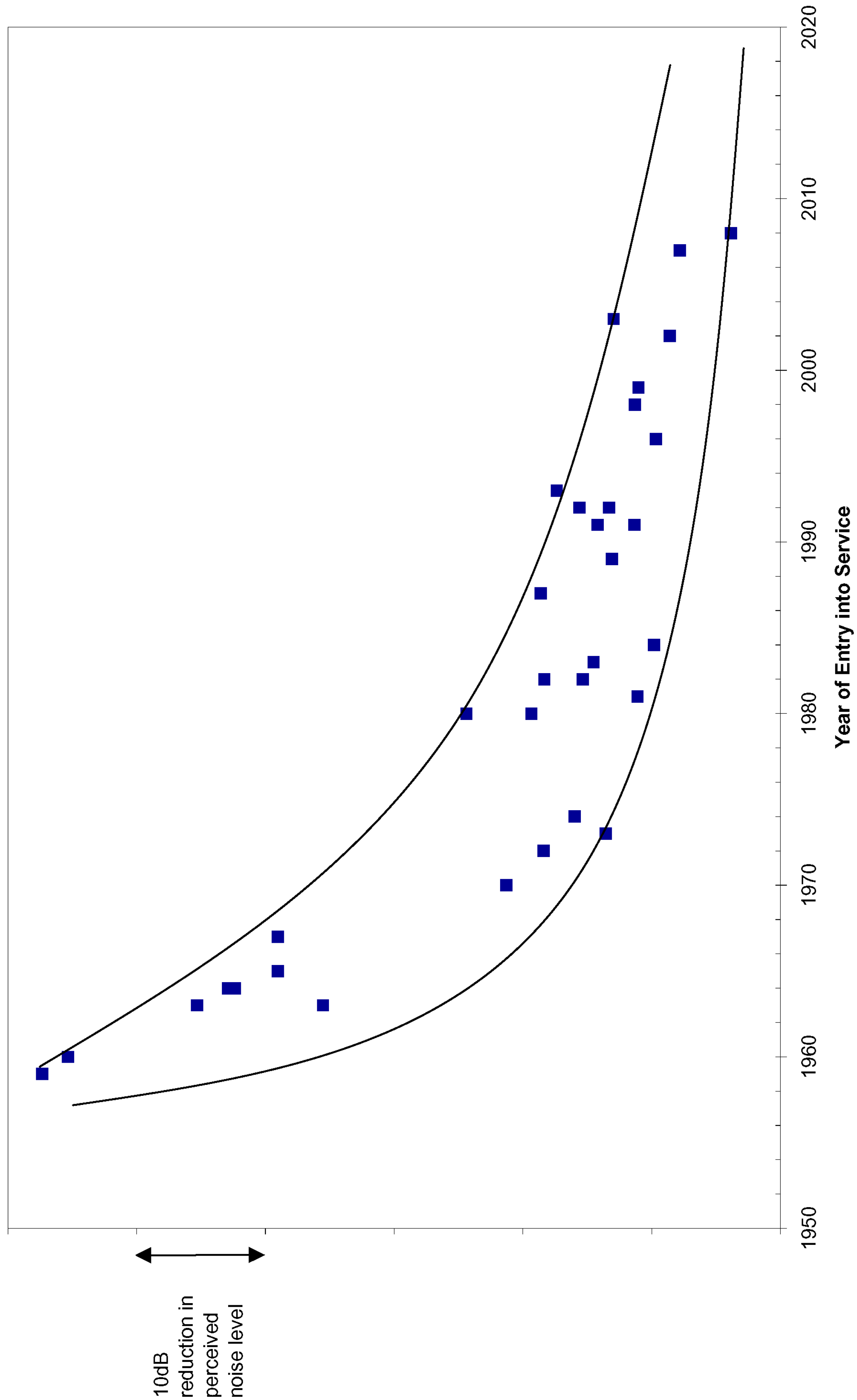


Figure 2.2: Departure noise footprints (80 & 90dBA SEL) for selected existing and future aircraft types

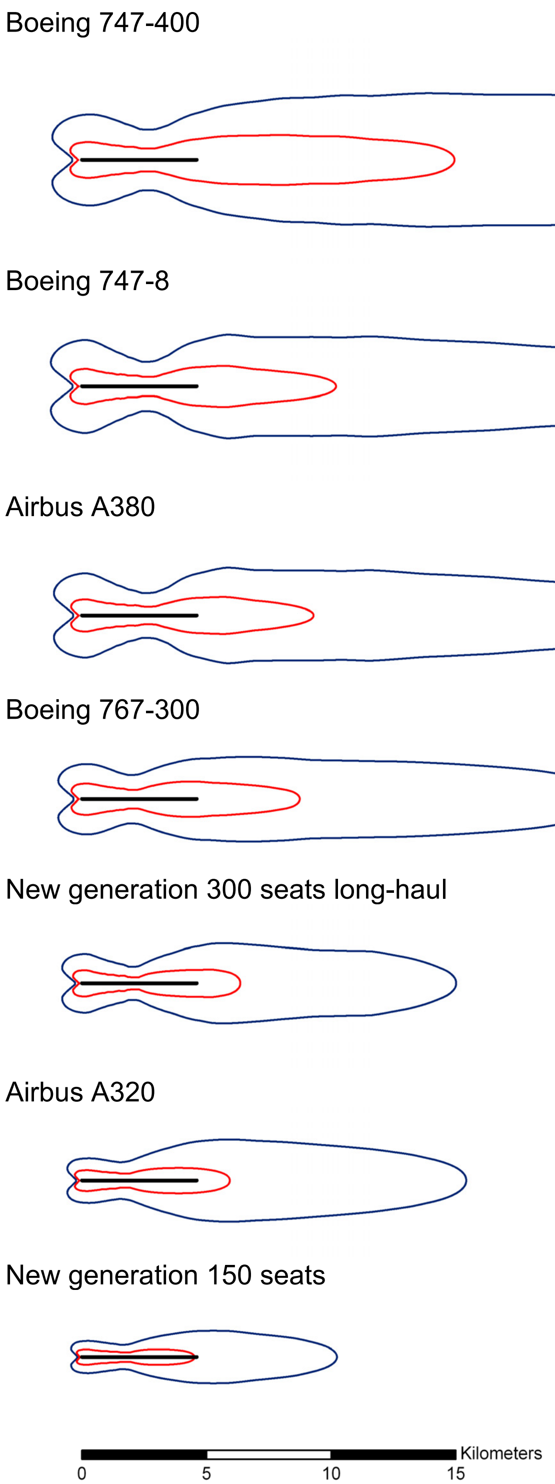
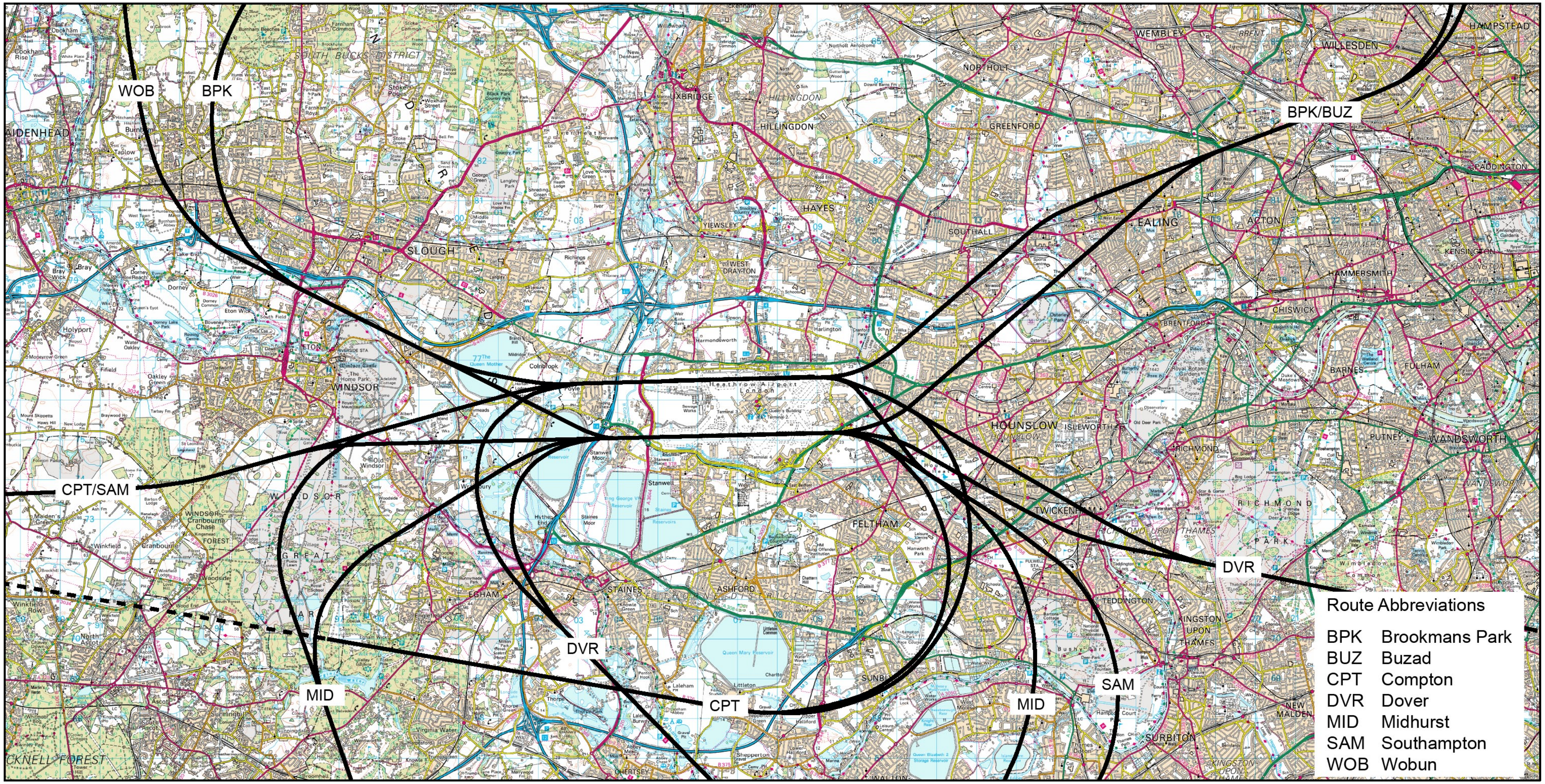


Figure 2.3: Heathrow nominal departure SIDs



0 5 10 15 20 25 Kilometres

Figure 2.4: Indicative Heathrow 2015 mixed mode departure SIDs

0 5 10 15 20 25 Kilometres

Figure 2.5: Indicative Heathrow R3 (Option MLD) departure SIDs

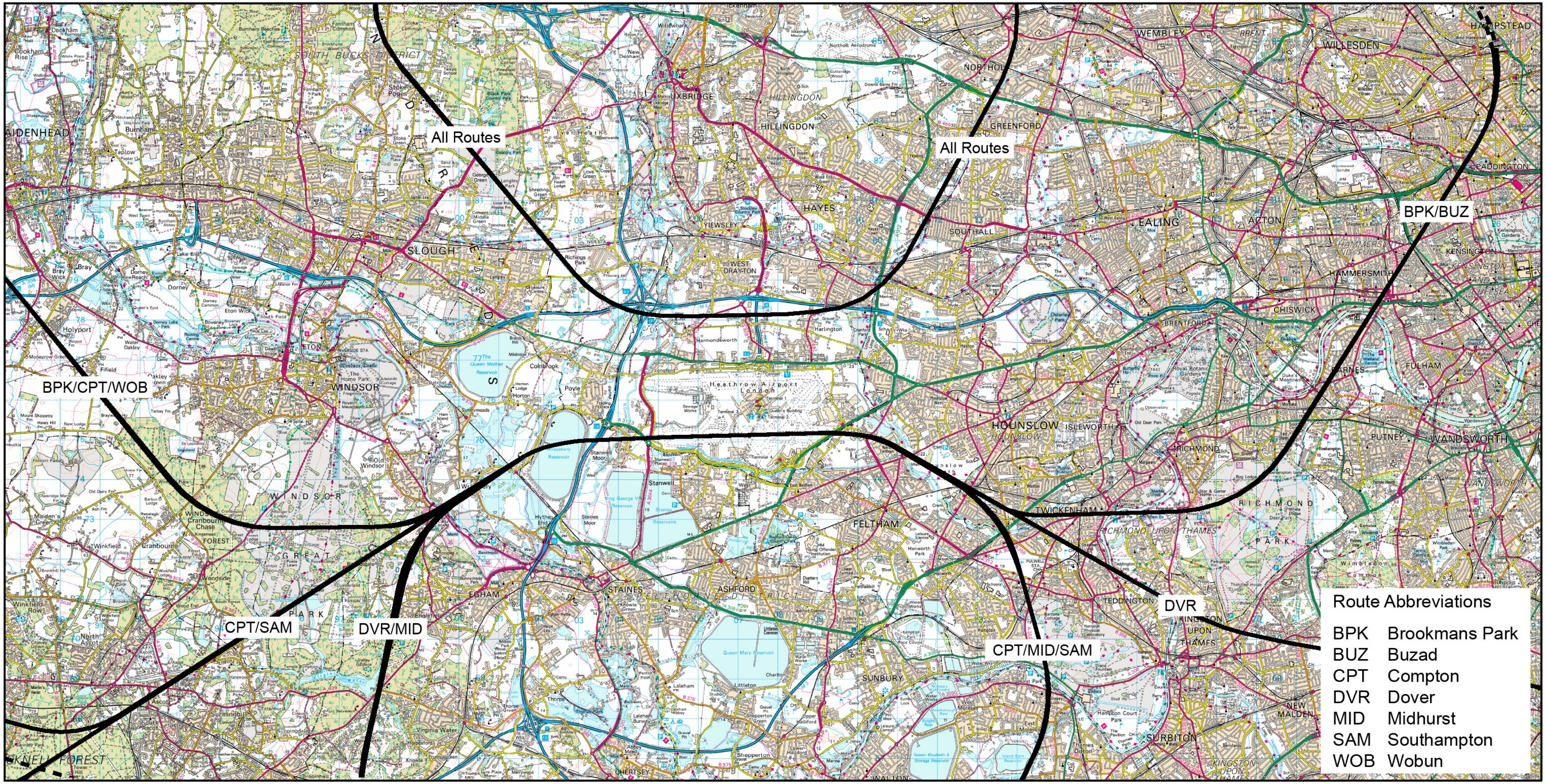


Figure 2.6: Indicative Heathrow R3 (Option MDL) departure SIDs

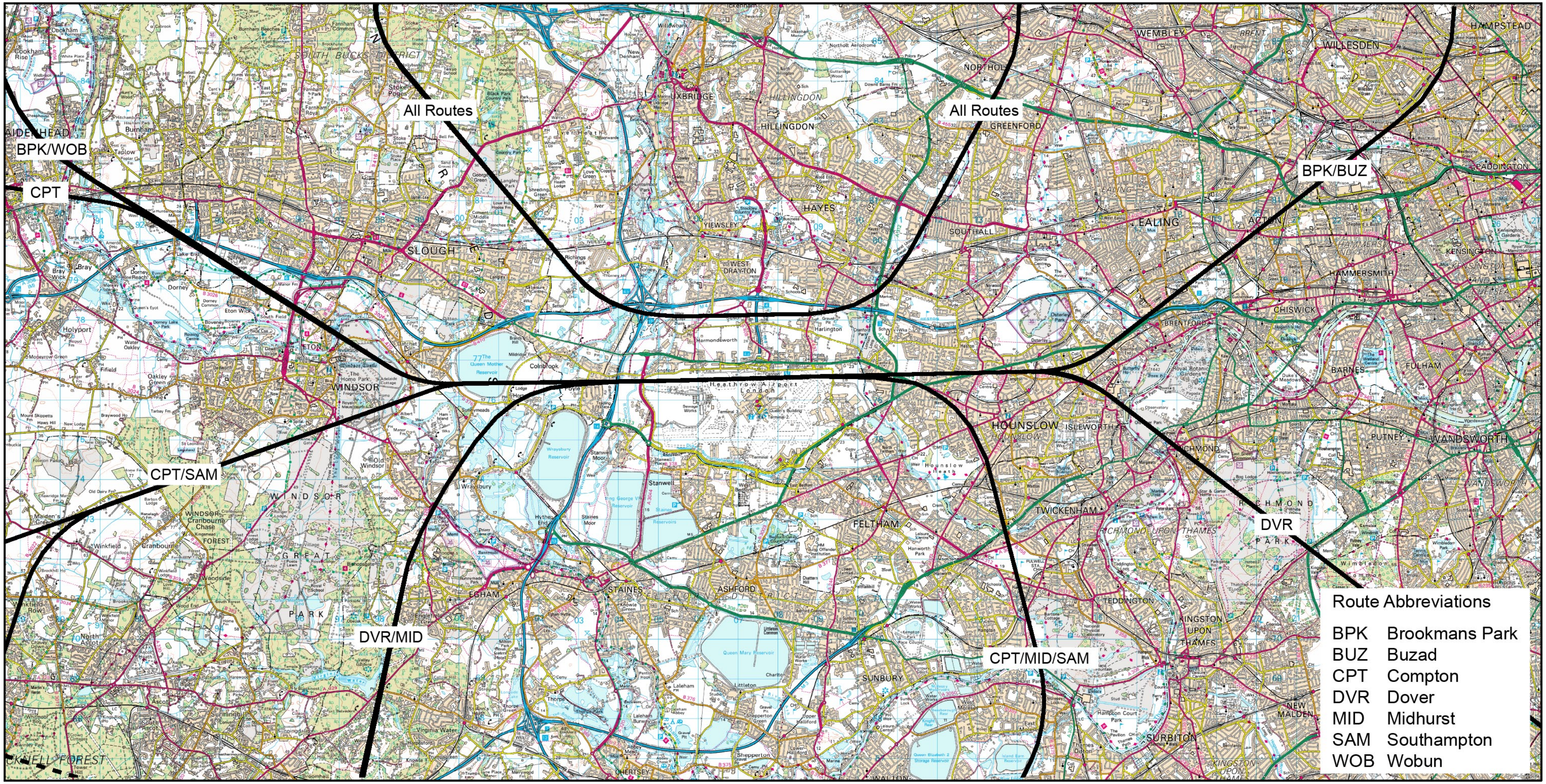
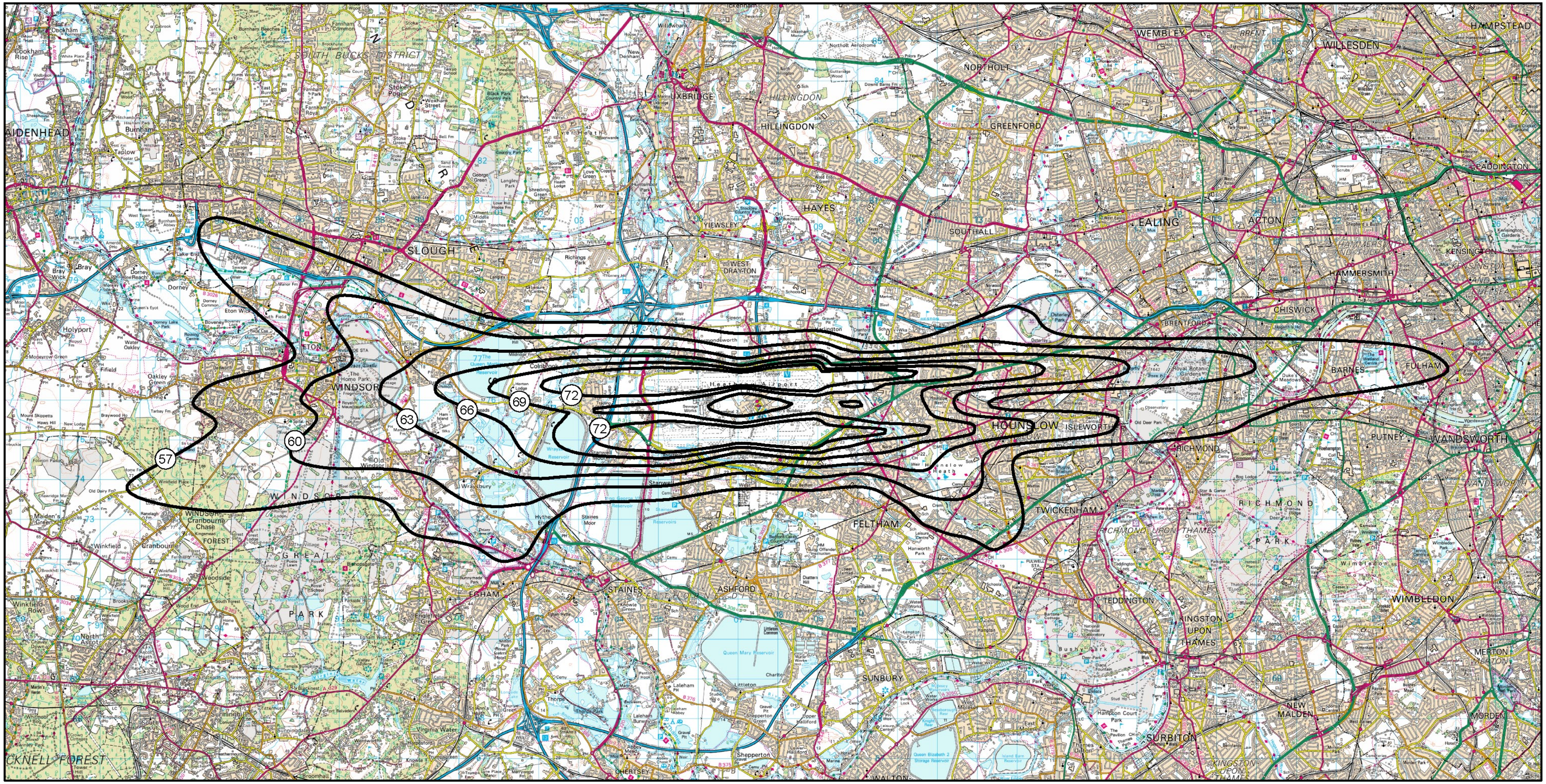


Figure 3.1: Heathrow 2002 16 hour average summer day noise contours



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0 5 10 15 20 25 Kilometres

Figure 3.2: 16 hour Leq noise exposure contours for 2015 segregated-mode (480,000 ATMs)

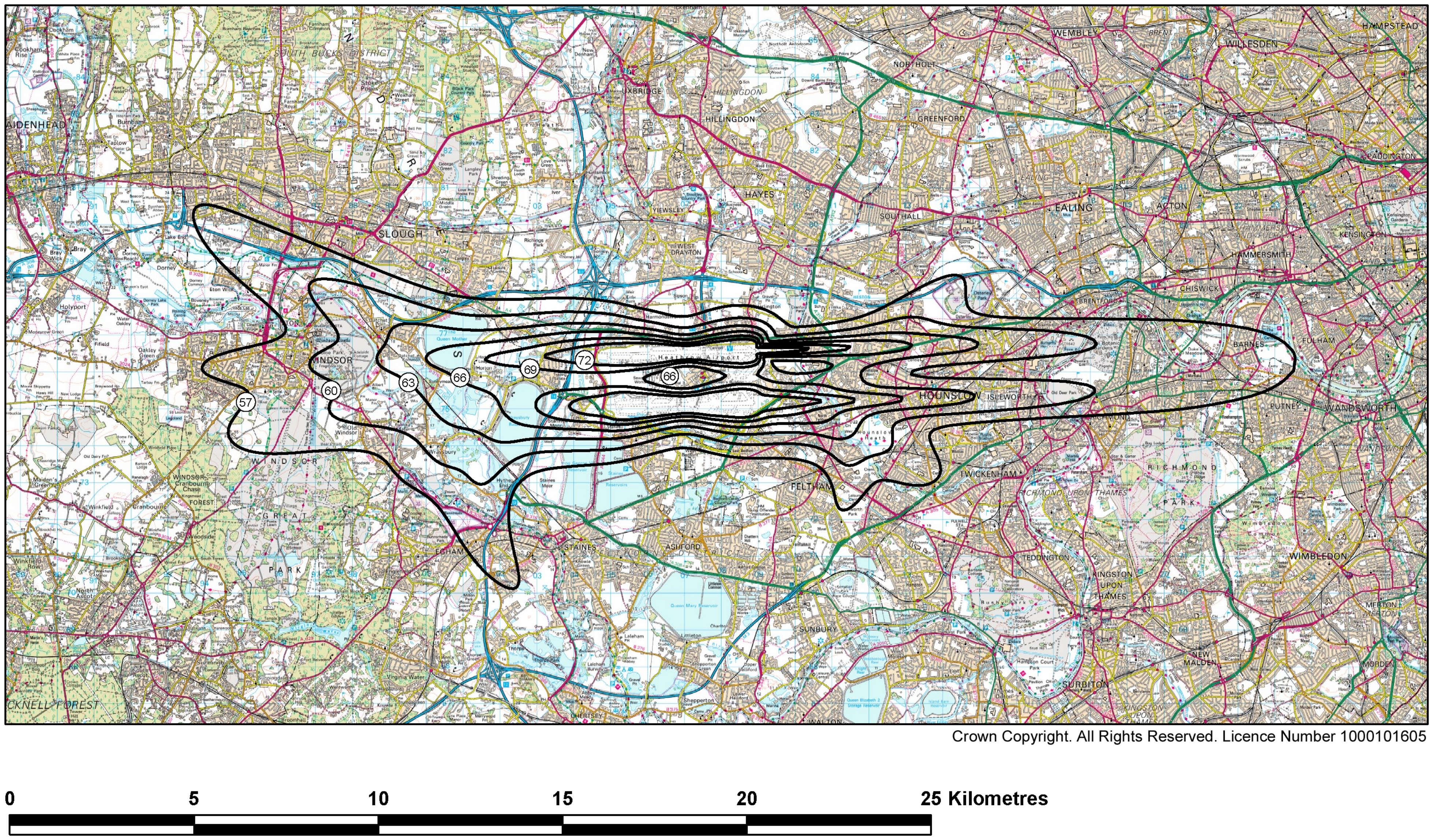


Figure 3.3: Indicative 16 hour Leq noise exposure contours for 2015 mixed-mode (540,000 ATMs)

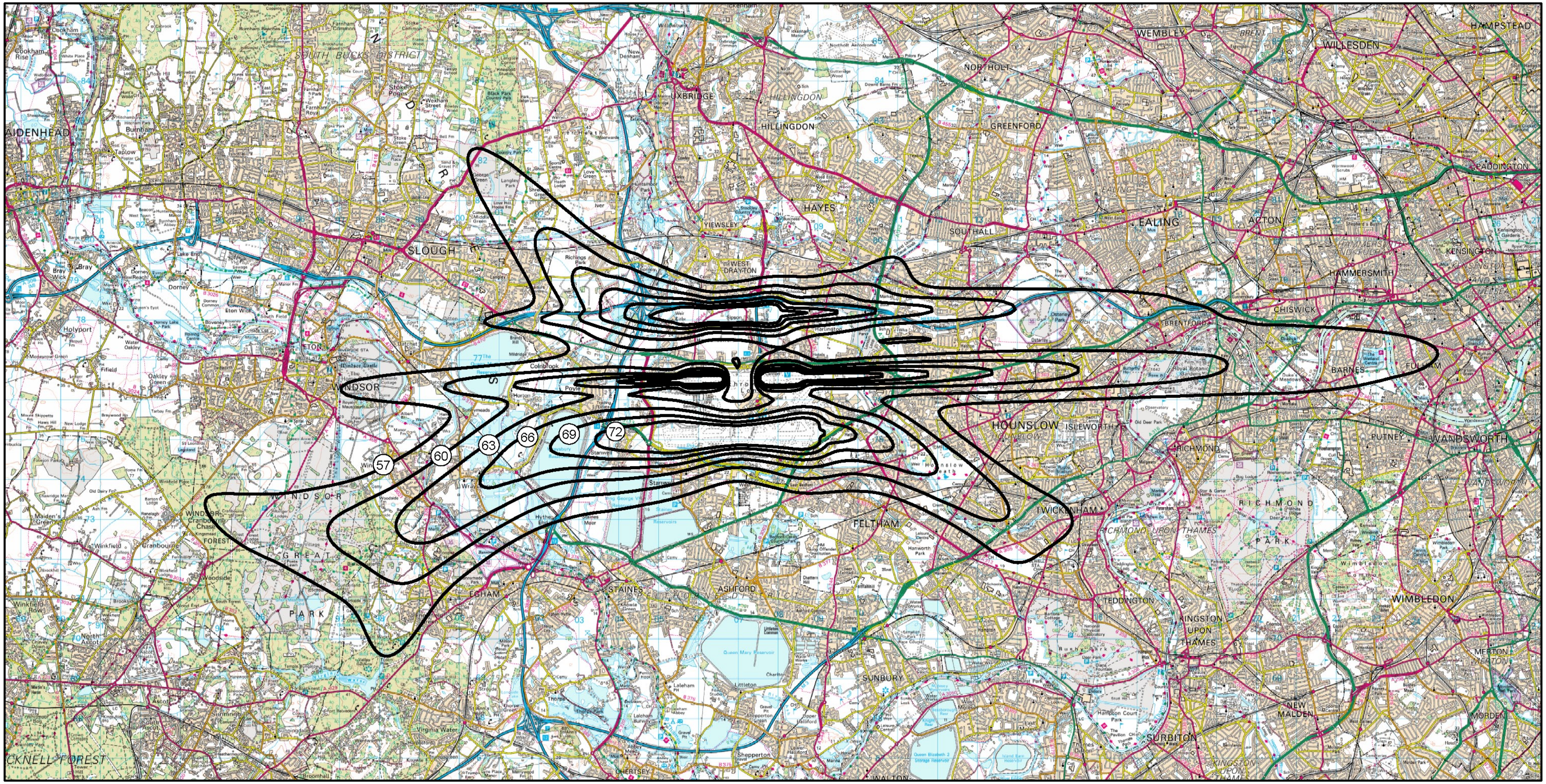
0 5 10 15 20 25 Kilometres

Figure 3.4: 57 dBA Leq Contour - Comparing 2015 mixed mode to 2002 and 2015 Segregated Mode (480,000 ATMs)

2002   2015 seg-mode   2015 mixed-mode

0 5 10 15 20 25 Kilometres

Figure 3.5: Indicative 16 hour Leq noise exposure contours for 2020 with a third runway (Option MLD) (615,000 ATMs)



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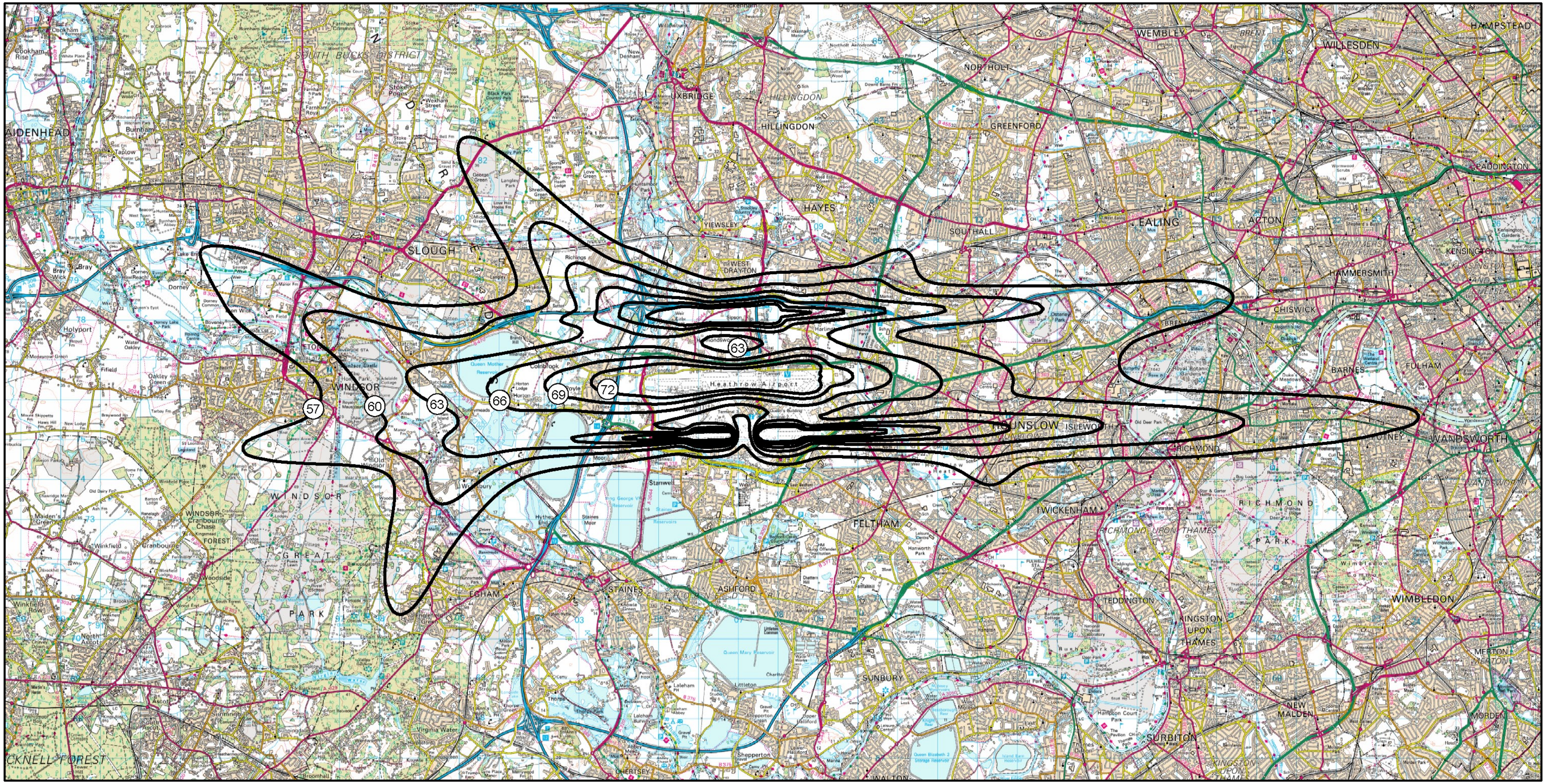
0 5 10 15 20 25 Kilometres

Figure 3.6: Indicative 16 hour Leq noise exposure contours for 2020 with a third runway (Option MDL) (670,000 ATMs)



0 5 10 15 20 25 Kilometres

Figure 3.7: Indicative 16 hour Leq noise exposure contours for 2020 with a third runway (Alternating) (605,000 ATMs)

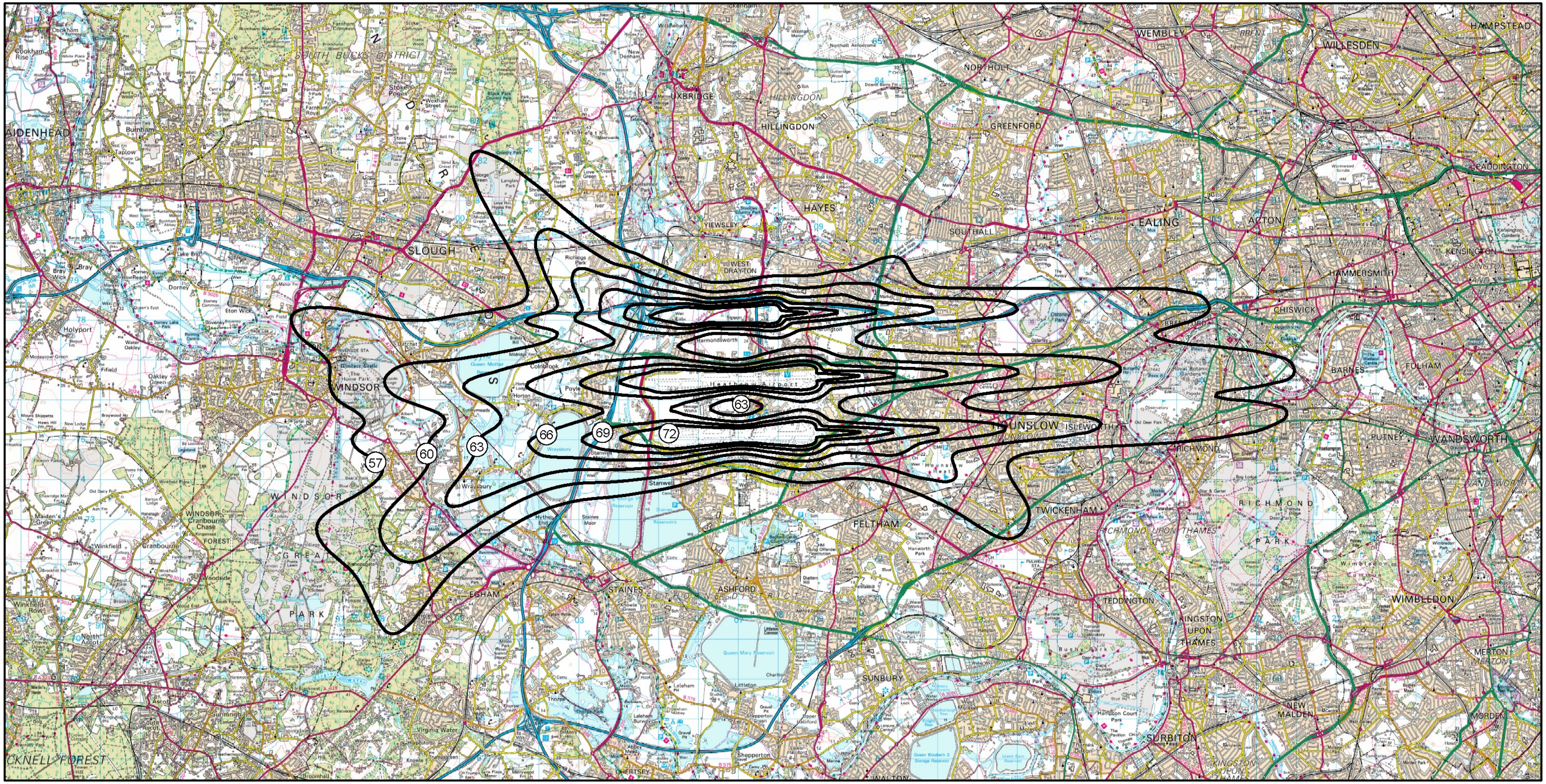
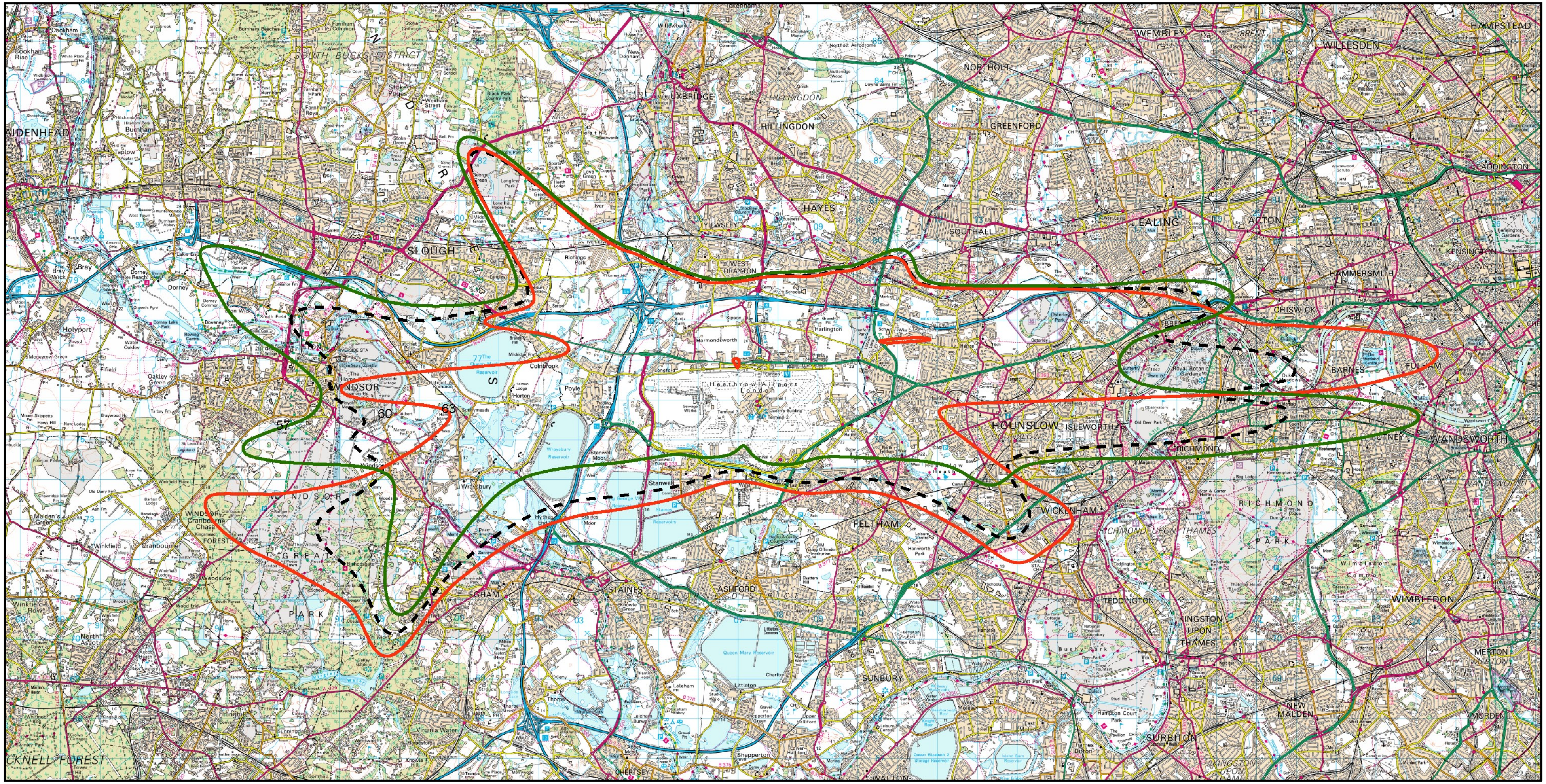


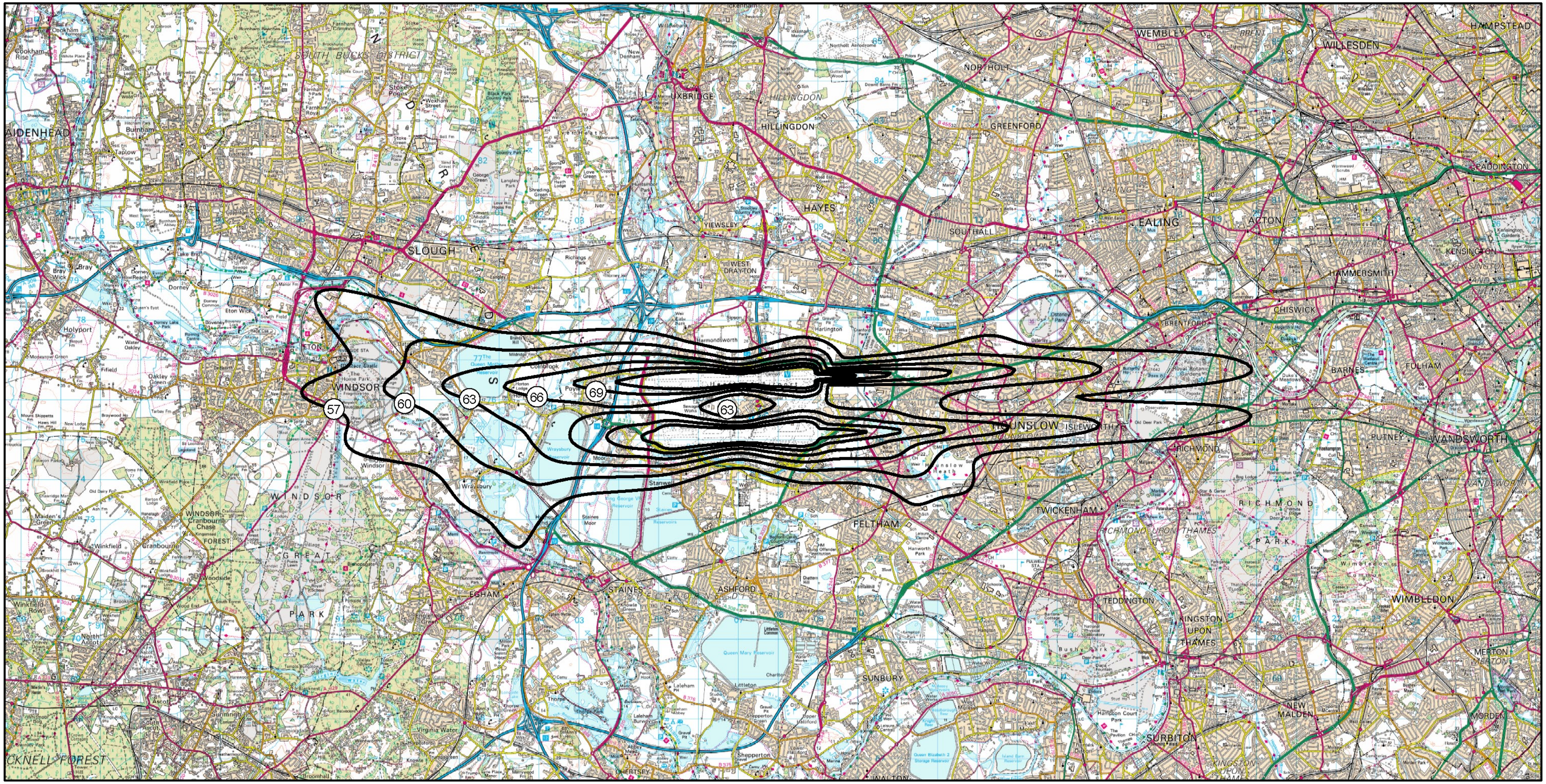
Figure 3.8: 57 dBA Leq Contour - Comparing 2020 R3 (Alternating) to 2020 R3 (Option MLD) and 2020 R3 (Option MDL)



- - - - 2020 R3 Alternating — 2020 R3 MLD — 2020 R3 MDL

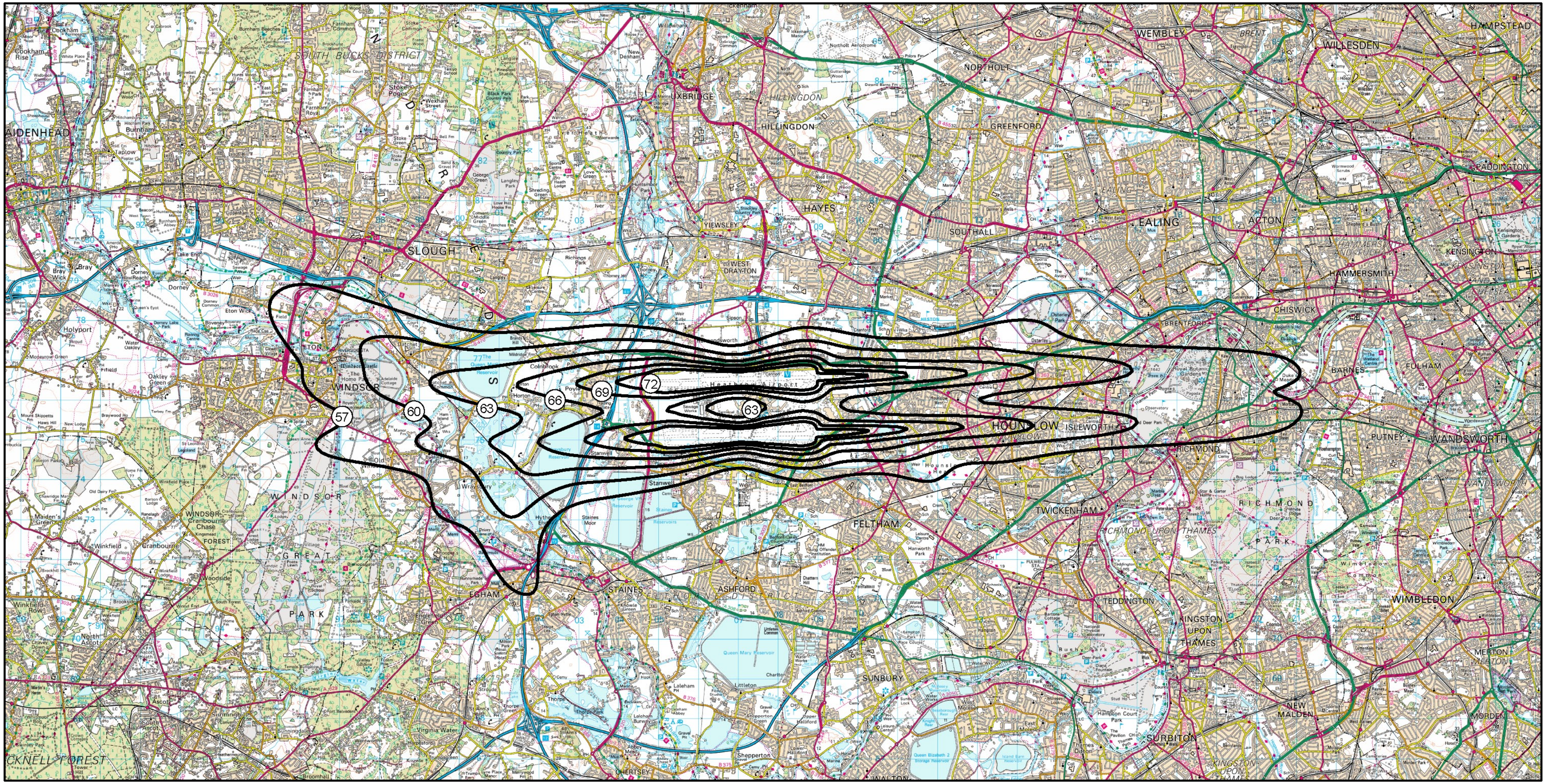
0 5 10 15 20 25 Kilometres

Figure 3.9: Indicative 16 hour Leq noise exposure contours for 2030 segregated-mode (480,000 ATMs)



0 5 10 15 20 25 Kilometres

Figure 3.10: Indicative 16 hour Leq noise exposure contours for 2030 mixed-mode (540,000 ATMs)



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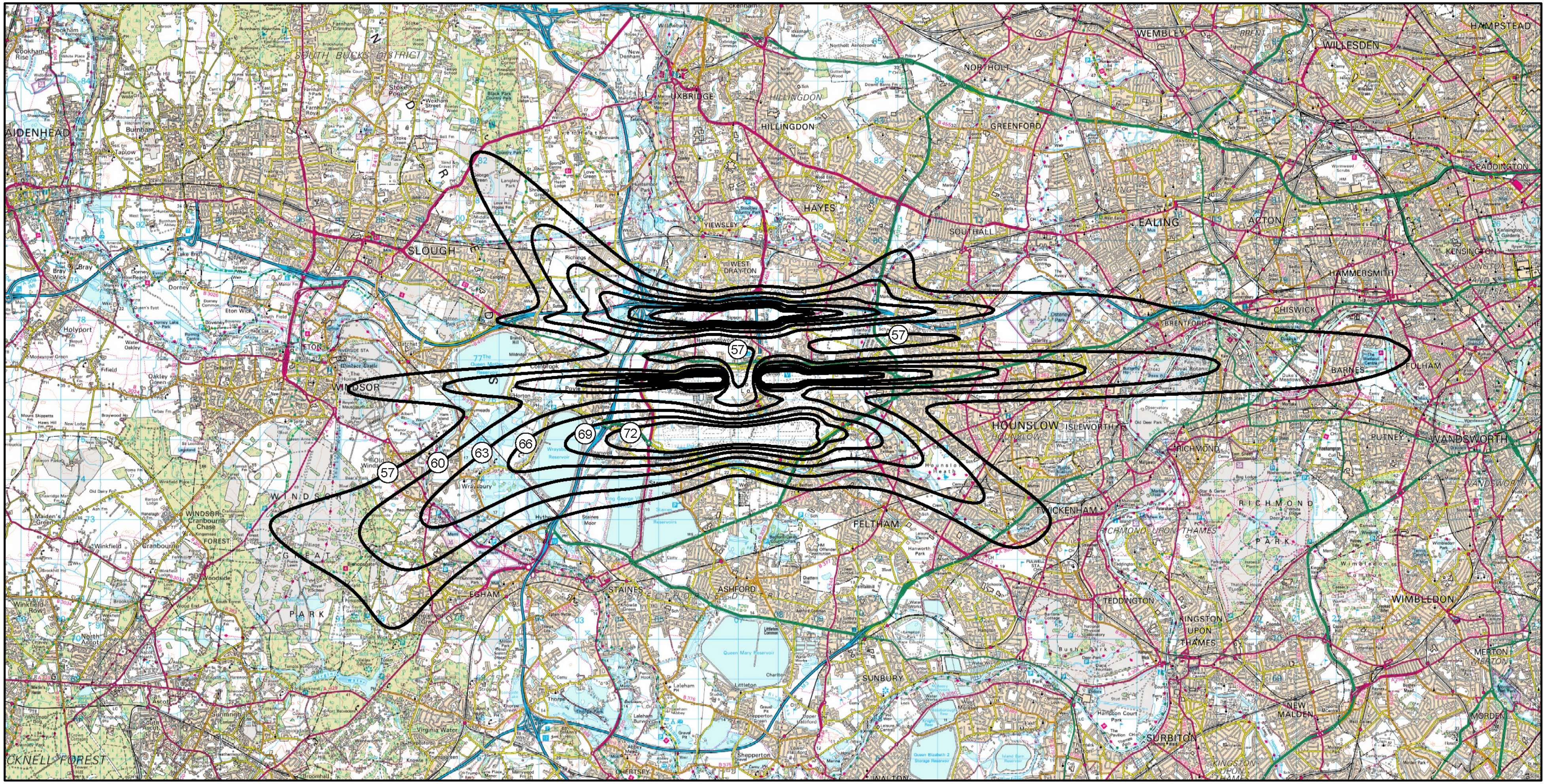
0 5 10 15 20 25 Kilometres

Figure 3.11: Indicative 16 hour Leq noise exposure contours for 2030 with a third runway (Option MLD) (702,000 ATMs)

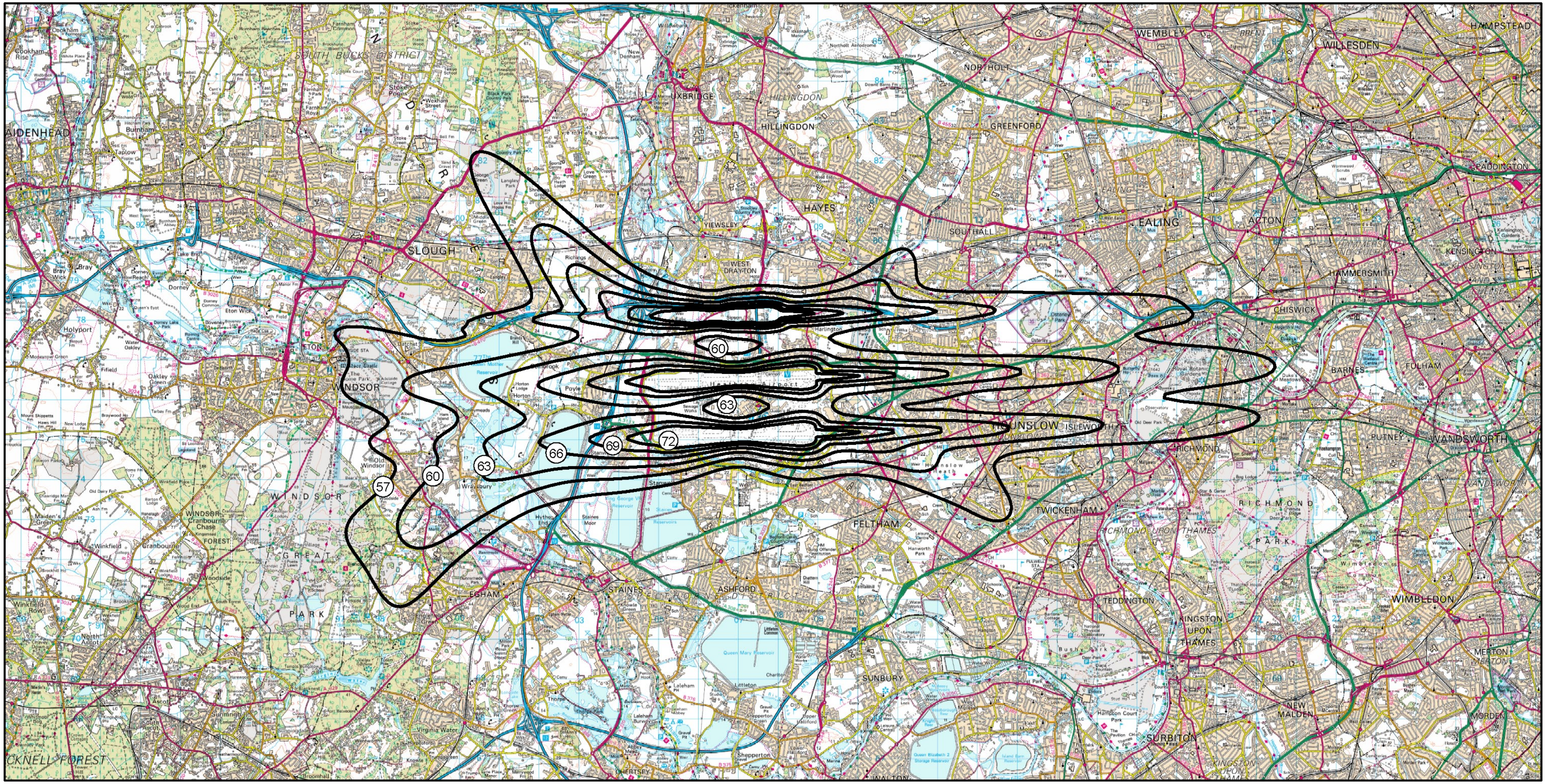


0 5 10 15 20 25 Kilometres

Figure 3.12: Indicative 16 hour Leq noise exposure contours for 2030 with a third runway (Option MDL) (702,000 ATMs)

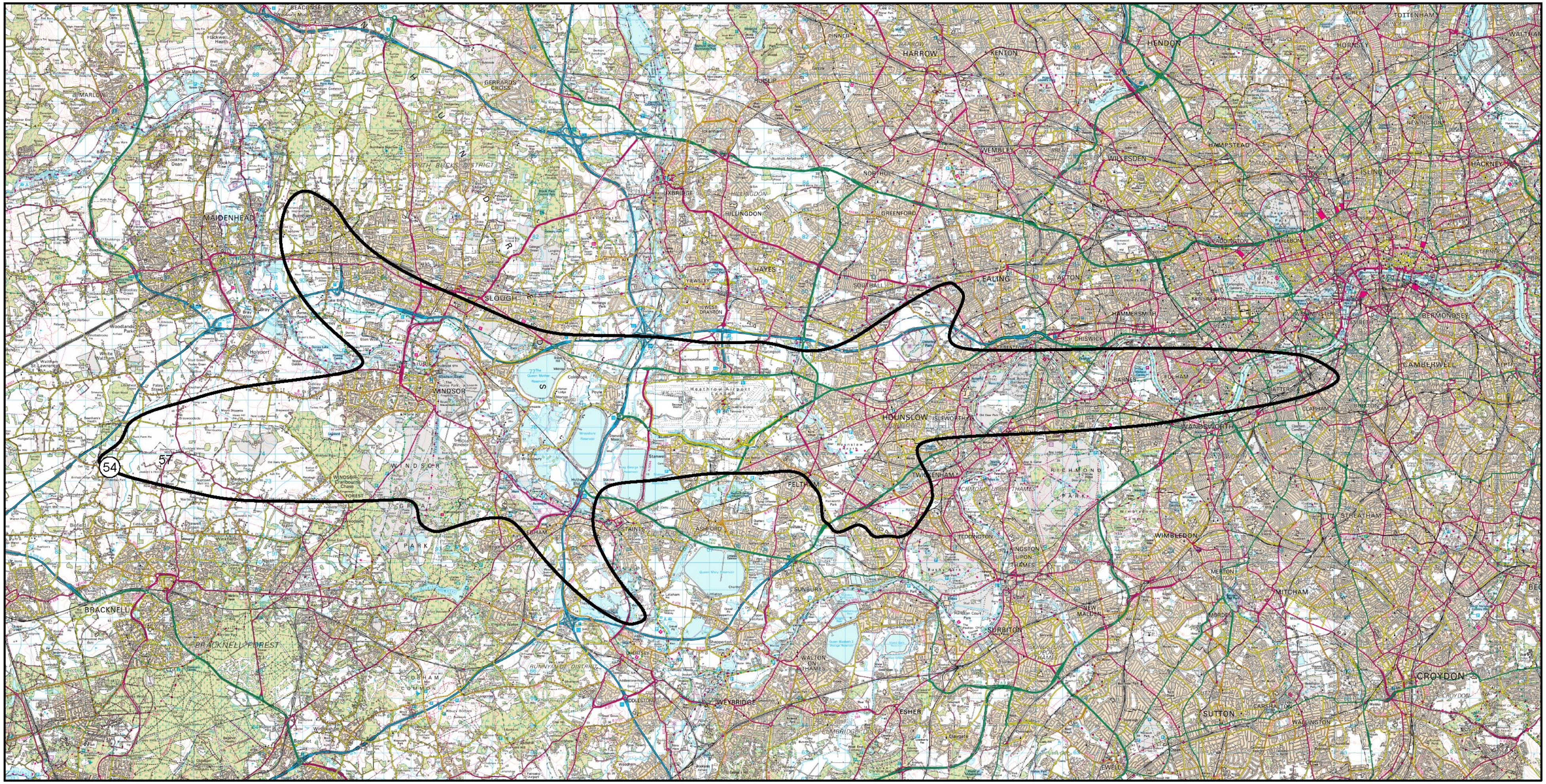
0 5 10 15 20 25 Kilometres

Figure 3.13: Indicative 16 hour Leq noise exposure contours for 2030 with a third runway (Alternating) (702,000 ATMs)



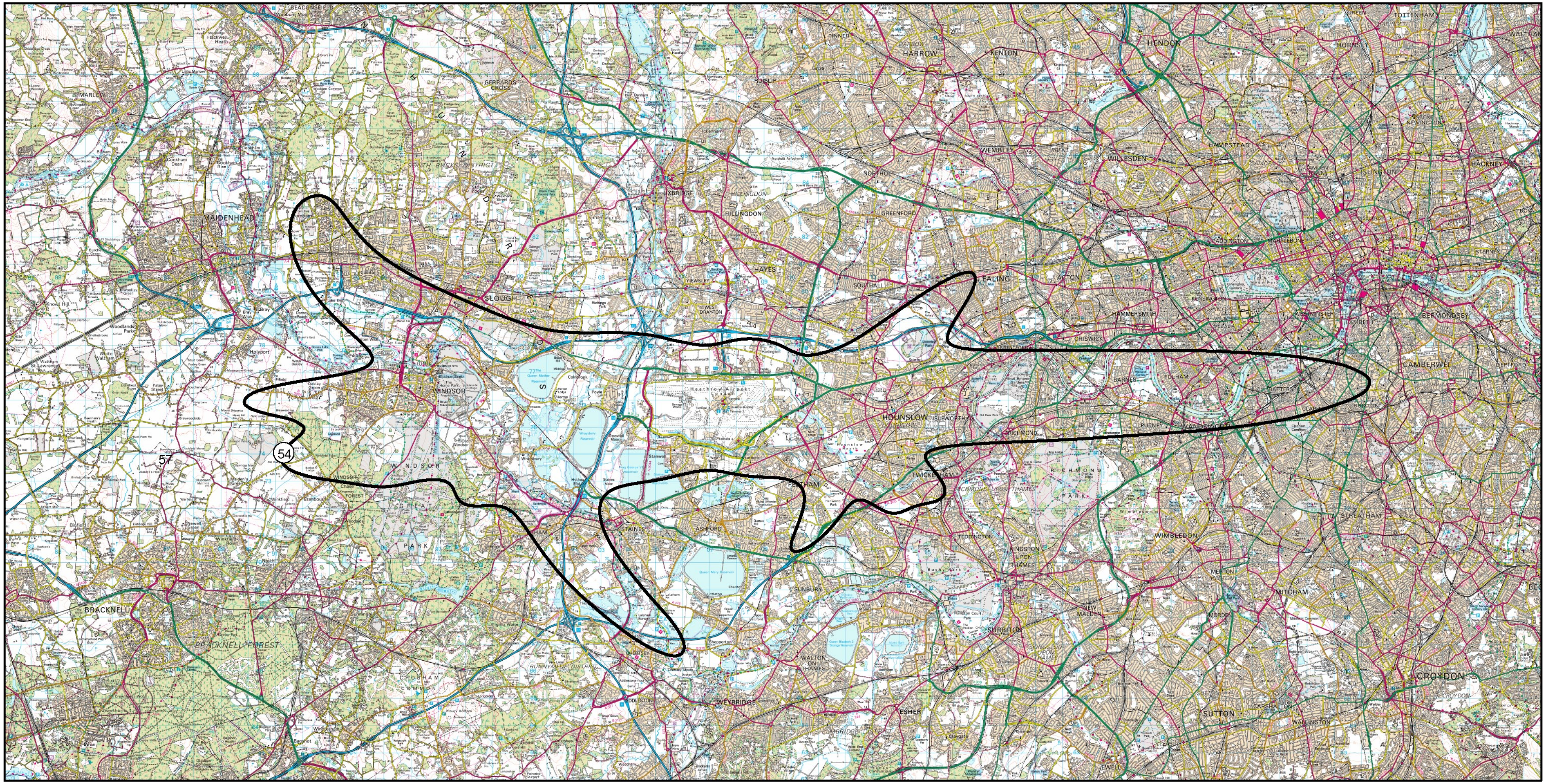
0 5 10 15 20 25 Kilometres

Figure 3.14: Heathrow Summer 2002 16 hour average summer day - 54dBA Leq noise contour



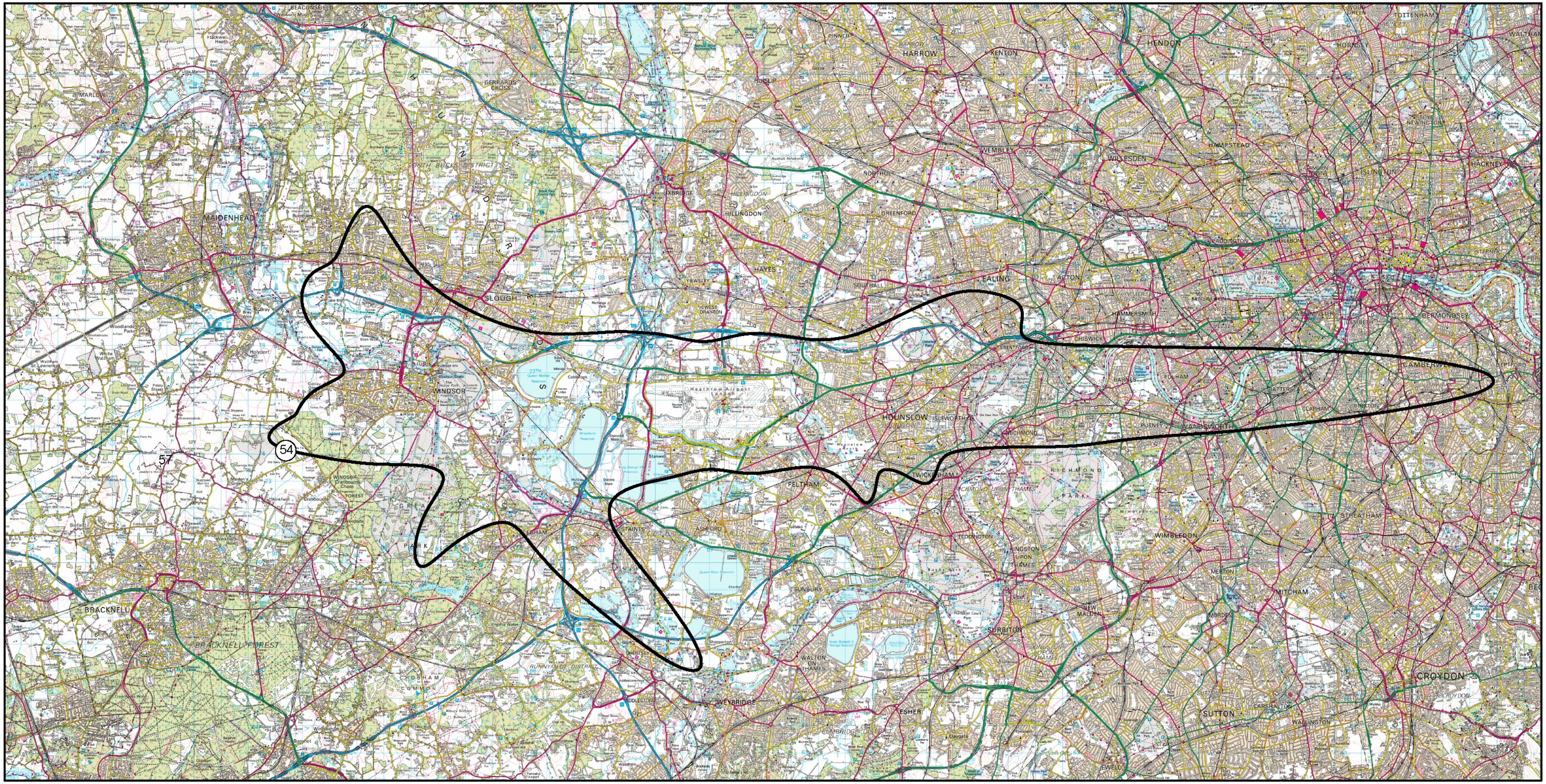
0 6 12 18 24 30 Kilometres

Figure 3.15: Indicative 16 hour 54dBA Leq noise exposure contour for 2015 segregated-mode (480,000 ATMs)



0 6 12 18 24 30 Kilometres

Figure 3.16: Indicative 16 hour 54dBA Leq noise exposure contour for 2015 mixed-mode (540,000 ATMs)



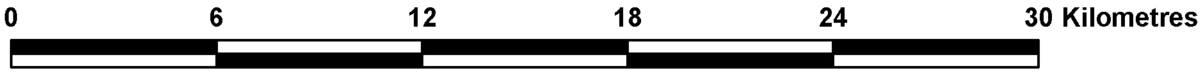
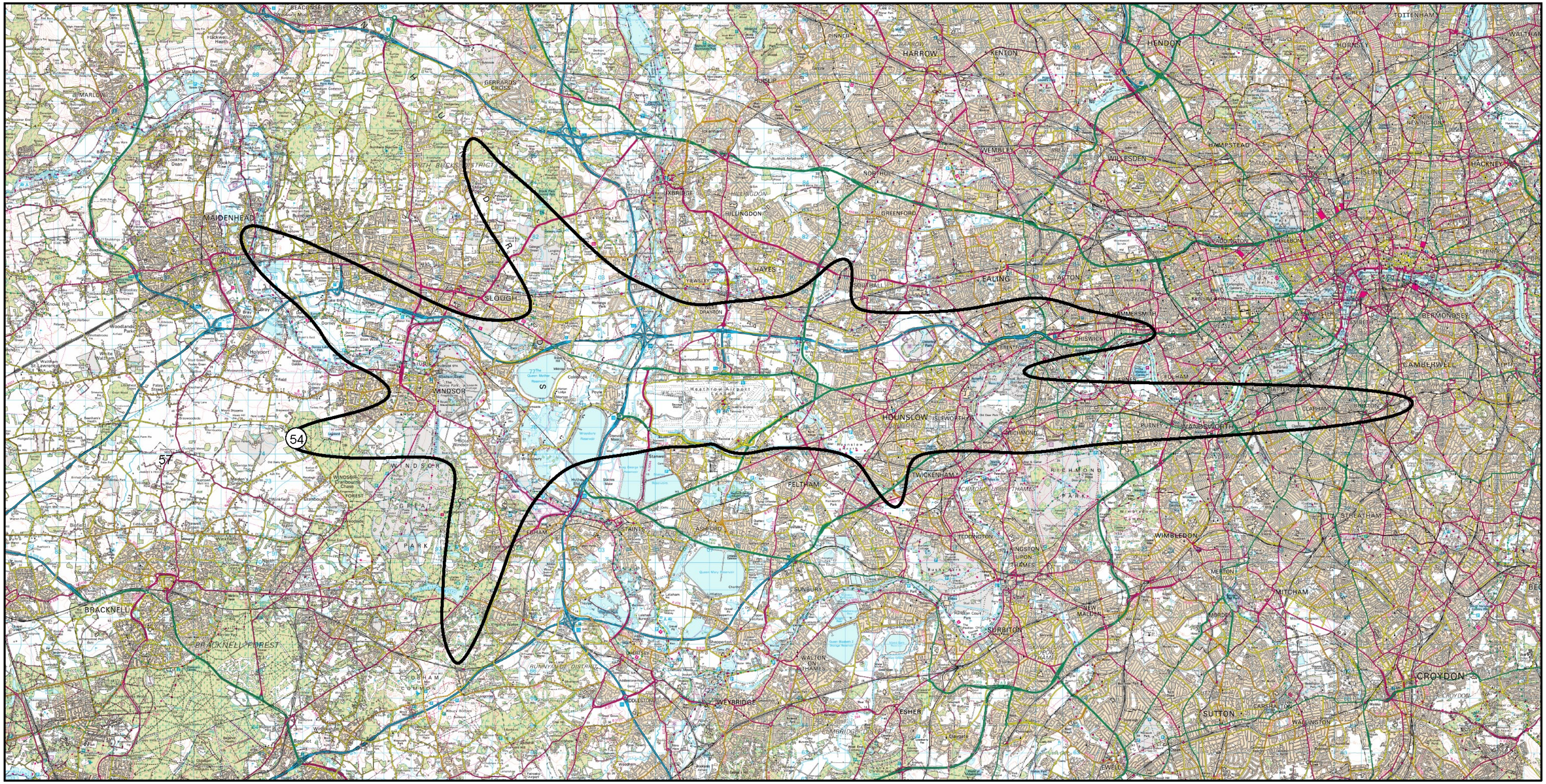


Figure 3.17: Indicative 16 hour 54dBA Leq noise exposure contour for 2020 with a third runway (Option MLD) (615,000 ATMs)

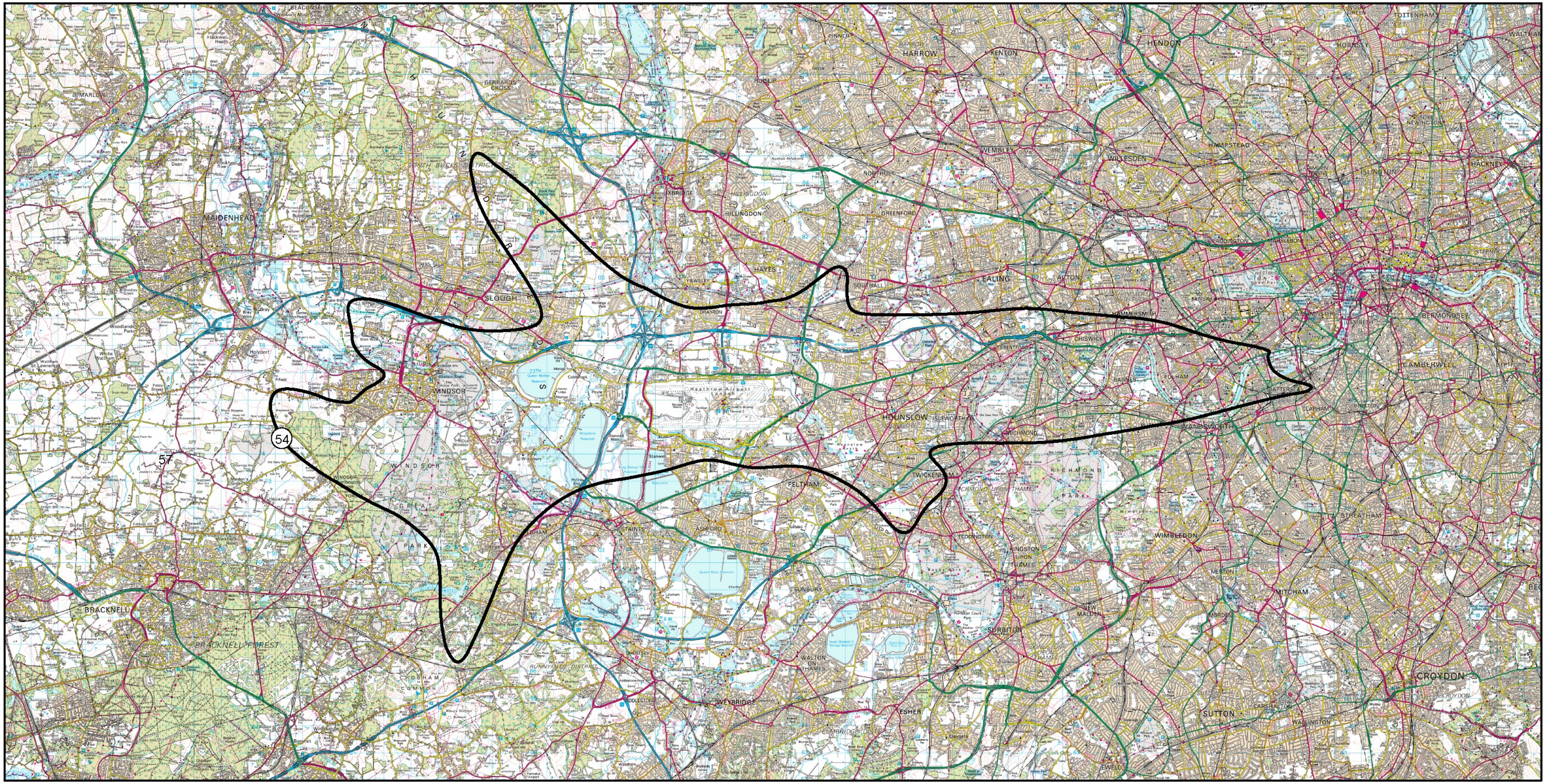
0 6 12 18 24 30 Kilometres

Figure 3.18: Indicative 16 hour 54dBA Leq noise exposure contour for 2020 with a third runway (Option MDL) (670,000 ATMs)



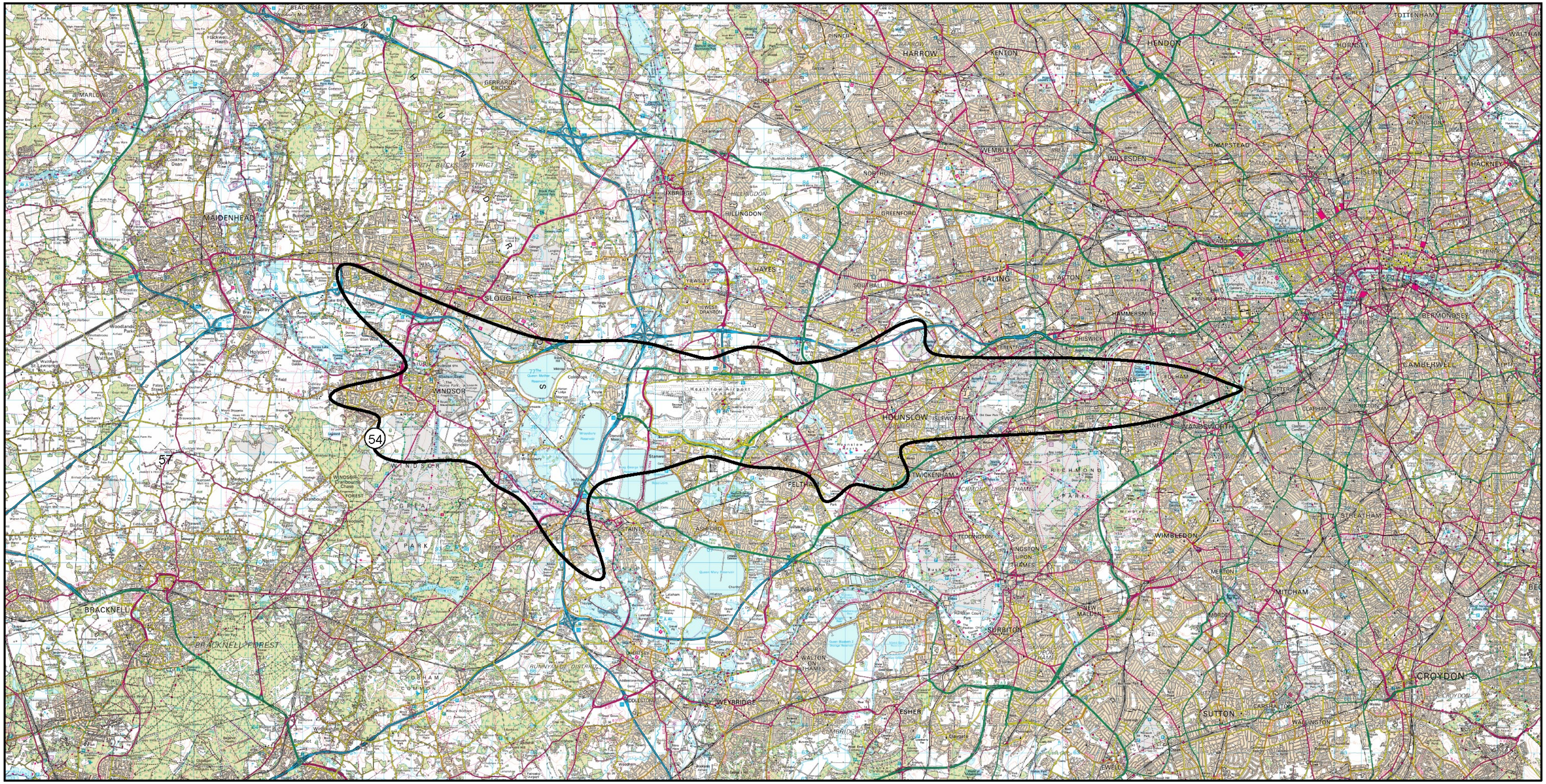
0 6 12 18 24 30 Kilometres

Figure 3.19: Indicative 16 hour 54dBA Leq noise exposure contour for 2020 with a third runway (Alternating) (605,000 ATMs)



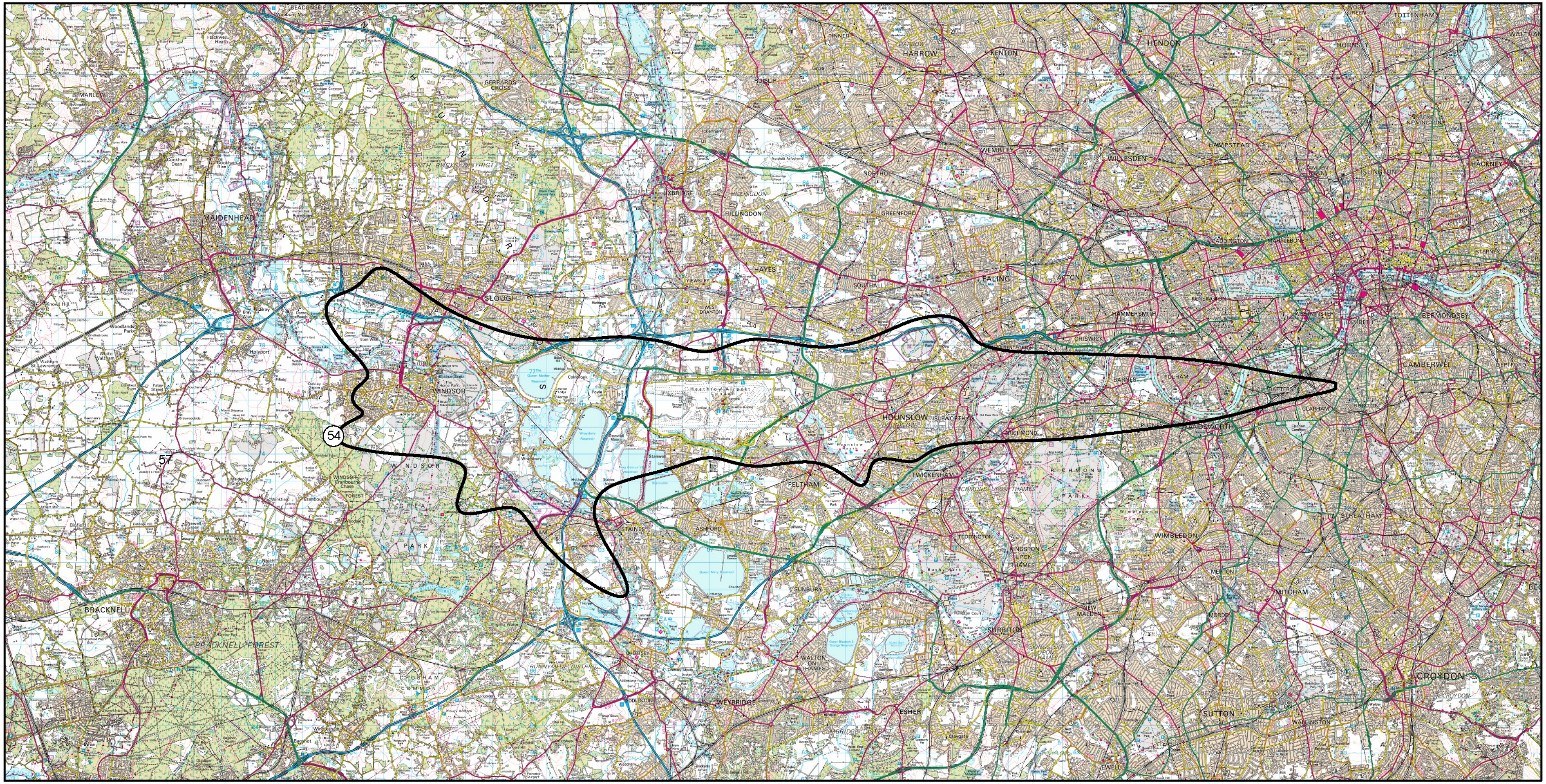
0 6 12 18 24 30 Kilometres

Figure 3.20: Indicative 16 hour 54dBA Leq noise exposure contour for 2030 segregated-mode (480,000 ATMs)



0 6 12 18 24 30 Kilometres

Figure 3.21: Indicative 16 hour 54dBA Leq noise exposure contour for 2030 mixed-mode (540,000 ATMs)



0 6 12 18 24 30 Kilometres

Figure 3.22: Indicative 16 hour 54dBA Leq noise exposure contour for 2030 with a third runway (Option MLD) (702,000 ATMs)

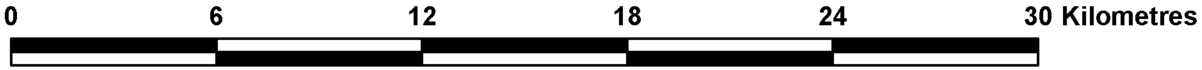
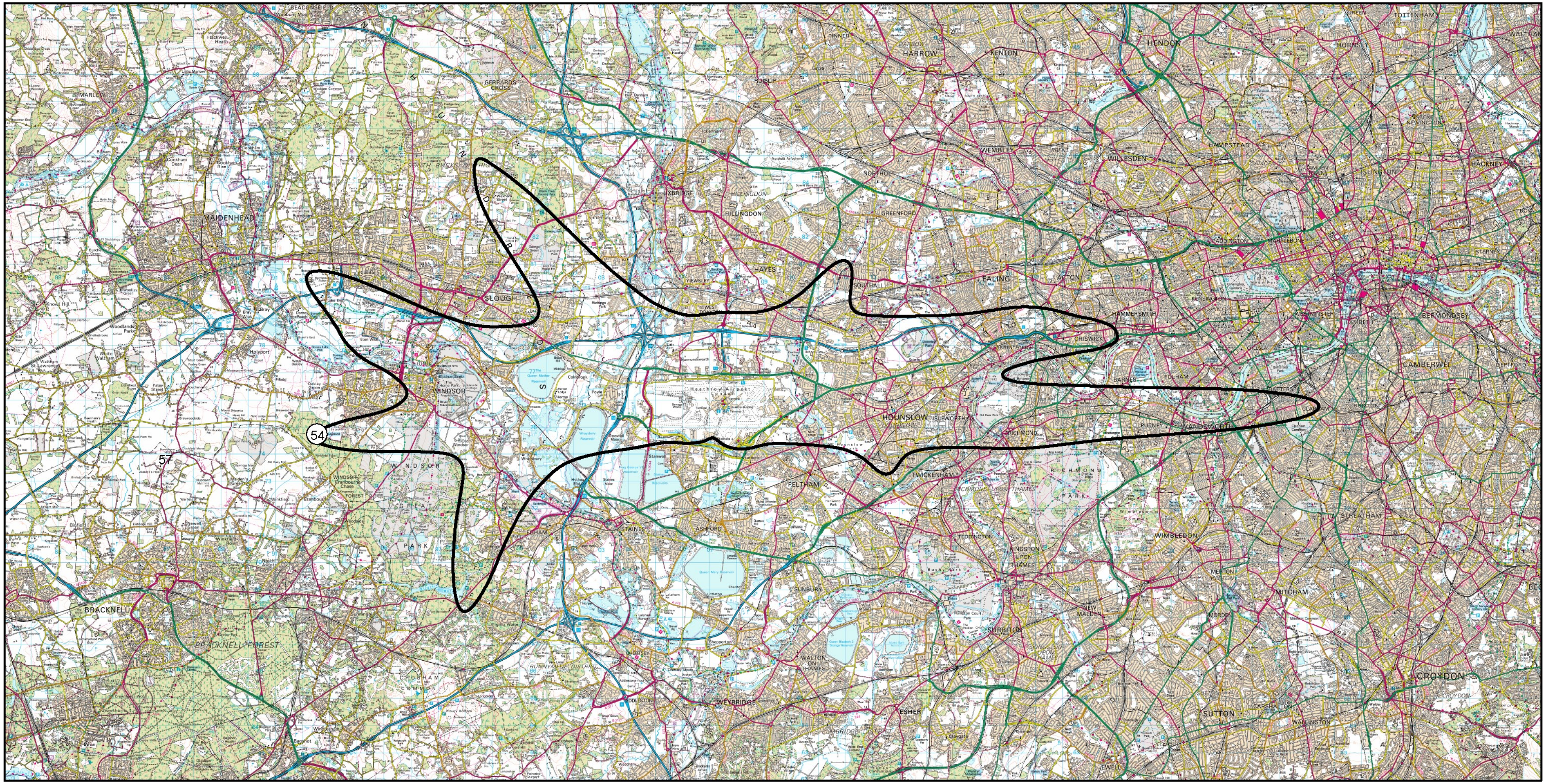
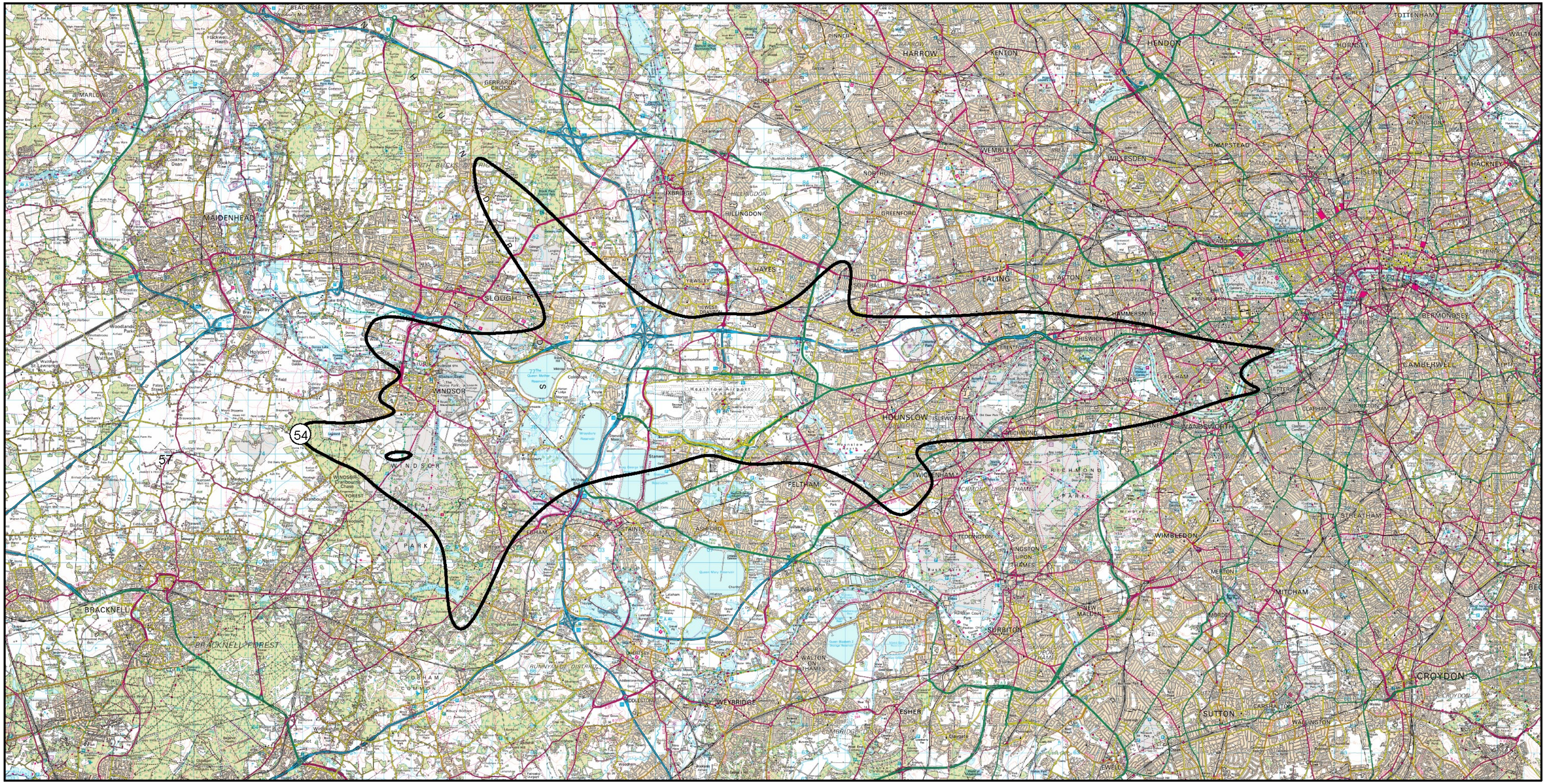


Figure 3.23: Indicative 16 hour 54dBA Leq noise exposure contour for 2030 with a third runway (Option MDL) (702,000 ATMs)



0 6 12 18 24 30 Kilometres

Figure 3.24: Indicative 16 hour 54dBA Leq noise exposure contour for 2030 with a third runway (Alternating) (702,000 ATMs)



0 6 12 18 24 30 Kilometres

Figure 4.1: Noise exposure changes for 2015 mixed-mode relative to 2002

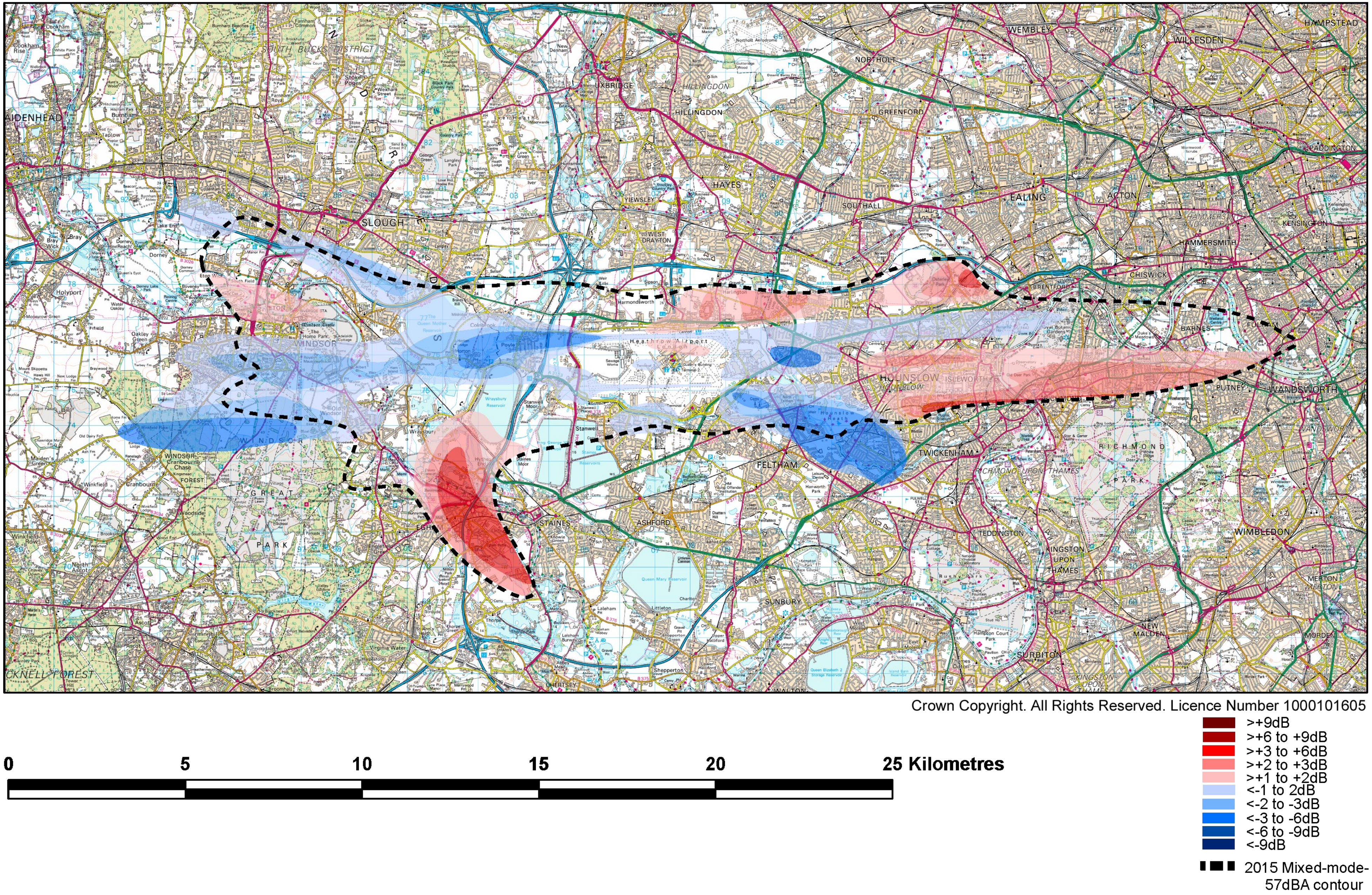


Figure 4.2: Noise exposure changes for 2030 R3 ‘alternating’ mode relative to 2002

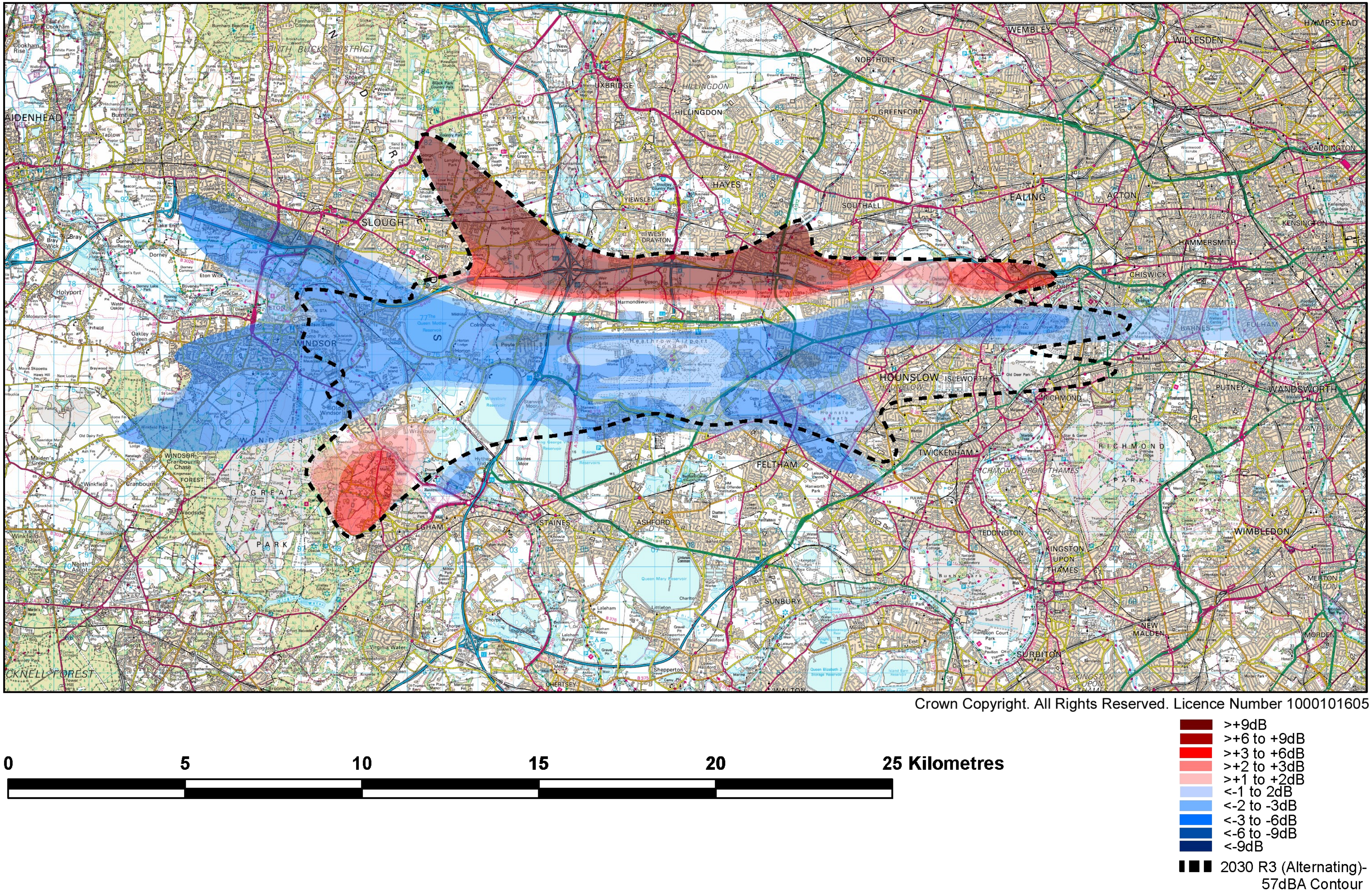


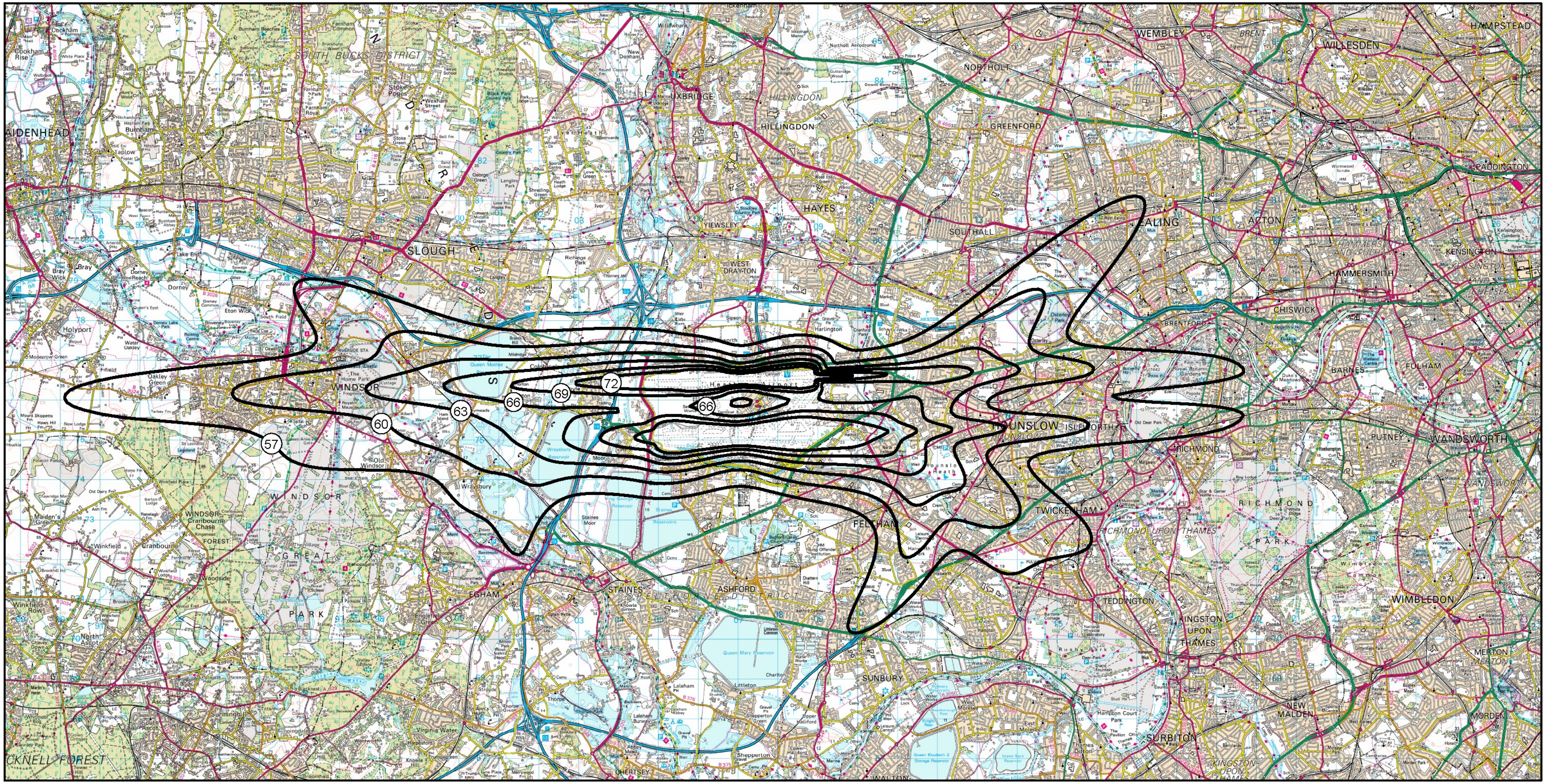
Figure 5.1: Indicative 16 hour Leq noise exposure contours for 2015 segregated-mode (480,000 ATMs) without Cranford agreement

0 5 10 15 20 25 Kilometres

Figure 5.2: Indicative 16 hour Leq noise exposure contours for 2030 segregated-mode (480,000 ATMs) without Cranford agreement

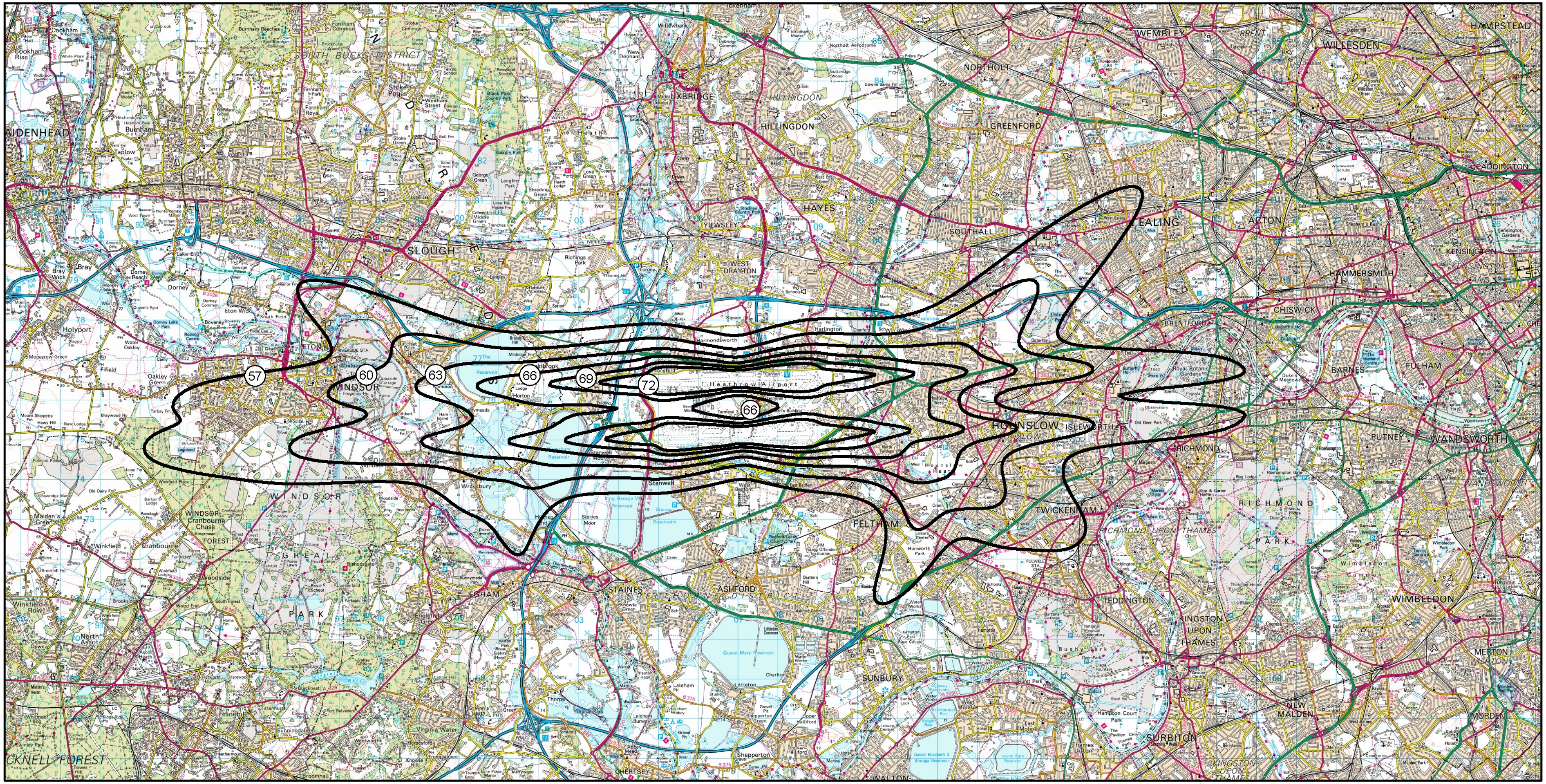
0 5 10 15 20 25 Kilometres

Figure 5.3: Indicative 16 hour Leq noise exposure contours for 2015 segregated-mode (480,000 ATMs) with easterly preference



0 5 10 15 20 25 Kilometres

Figure 5.4: Indicative 16 hour Leq noise exposure contours for 2015 segregated-mode (480,000 ATMs) with easterly preference and no Cranford agreement



0 5 10 15 20 25 Kilometres

Figure 5.5: Indicative 16 hour Leq noise exposure contours for 2015 mixed-mode (540,000 ATMs) with easterly preference

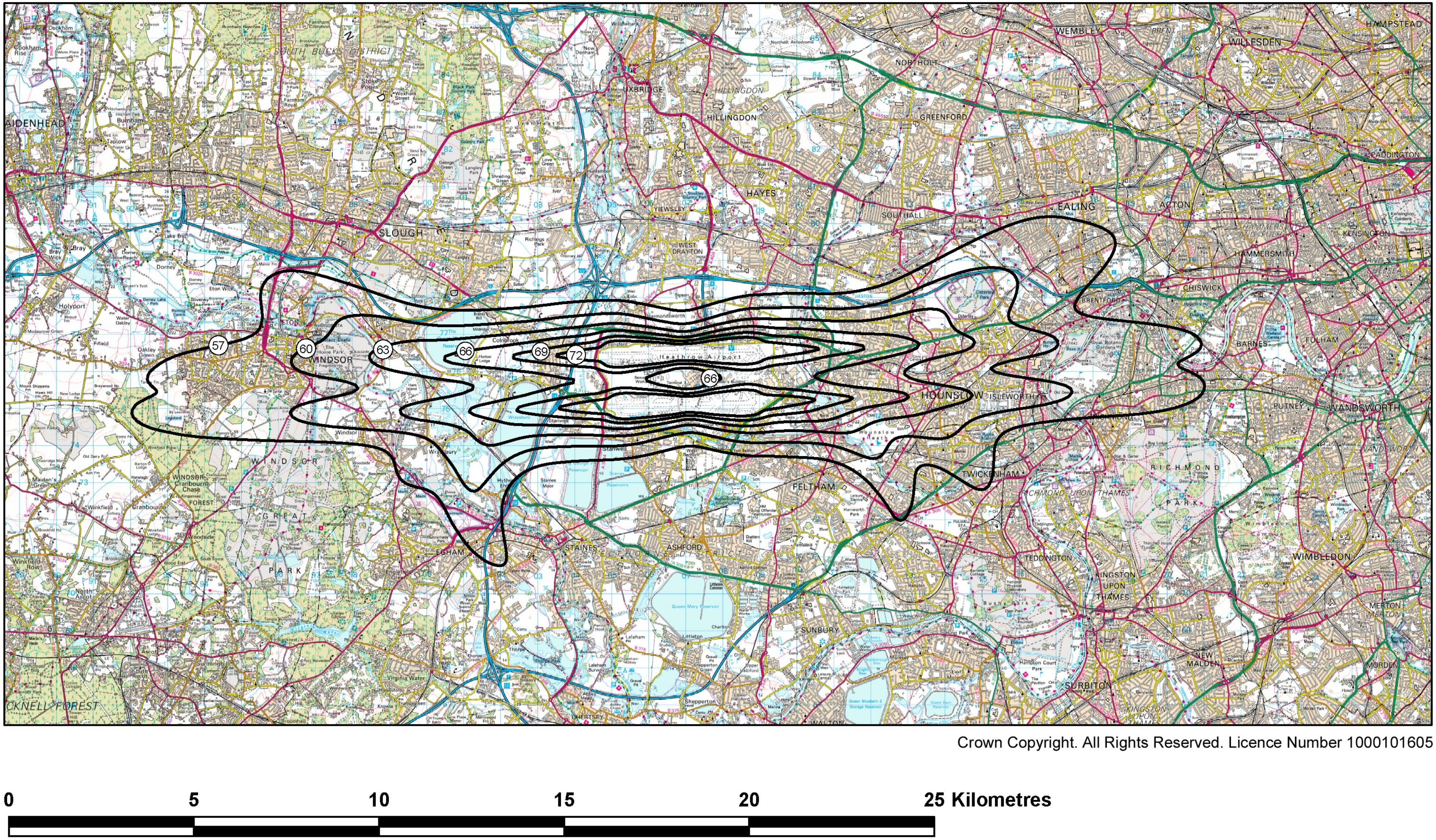
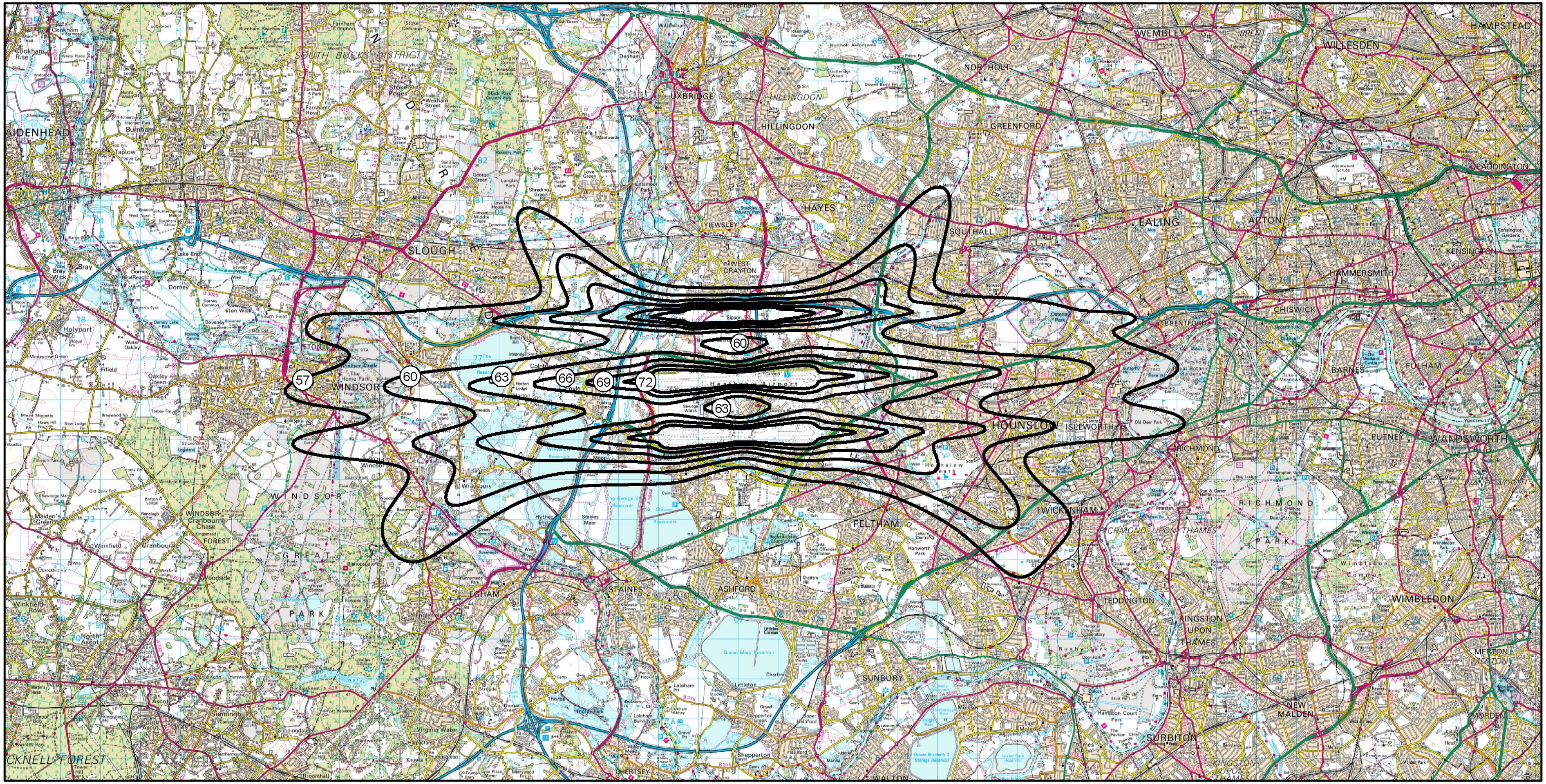
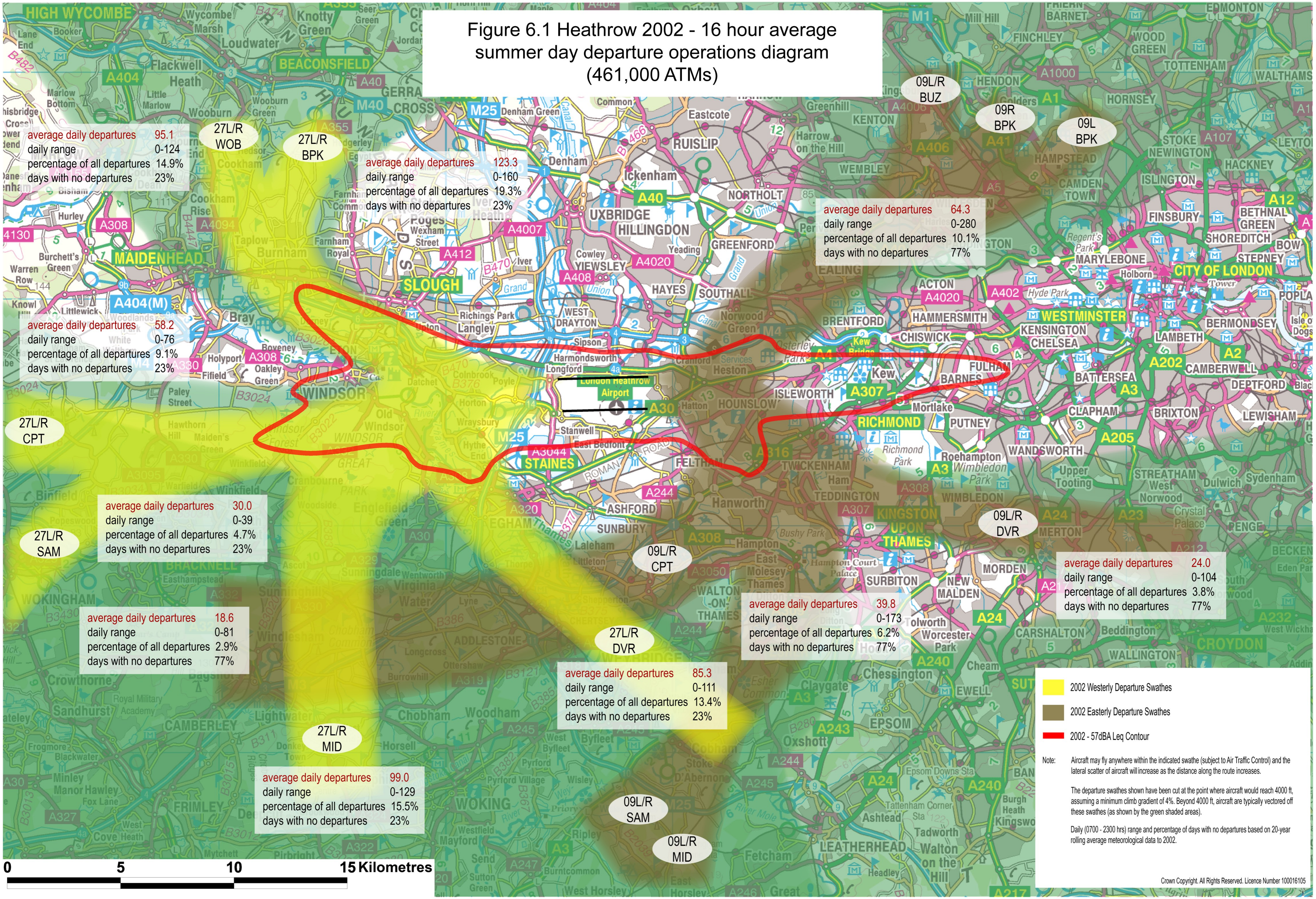


Figure 5.6: Indicative 16 hour Leq noise exposure contours for 2030 with a third runway (Alternating) (702,000 ATMs) with easterly preference



0 5 10 15 20 25 Kilometres

Figure 6.1 Heathrow 2002 - 16 hour average summer day departure operations diagram (461,000 ATMs)



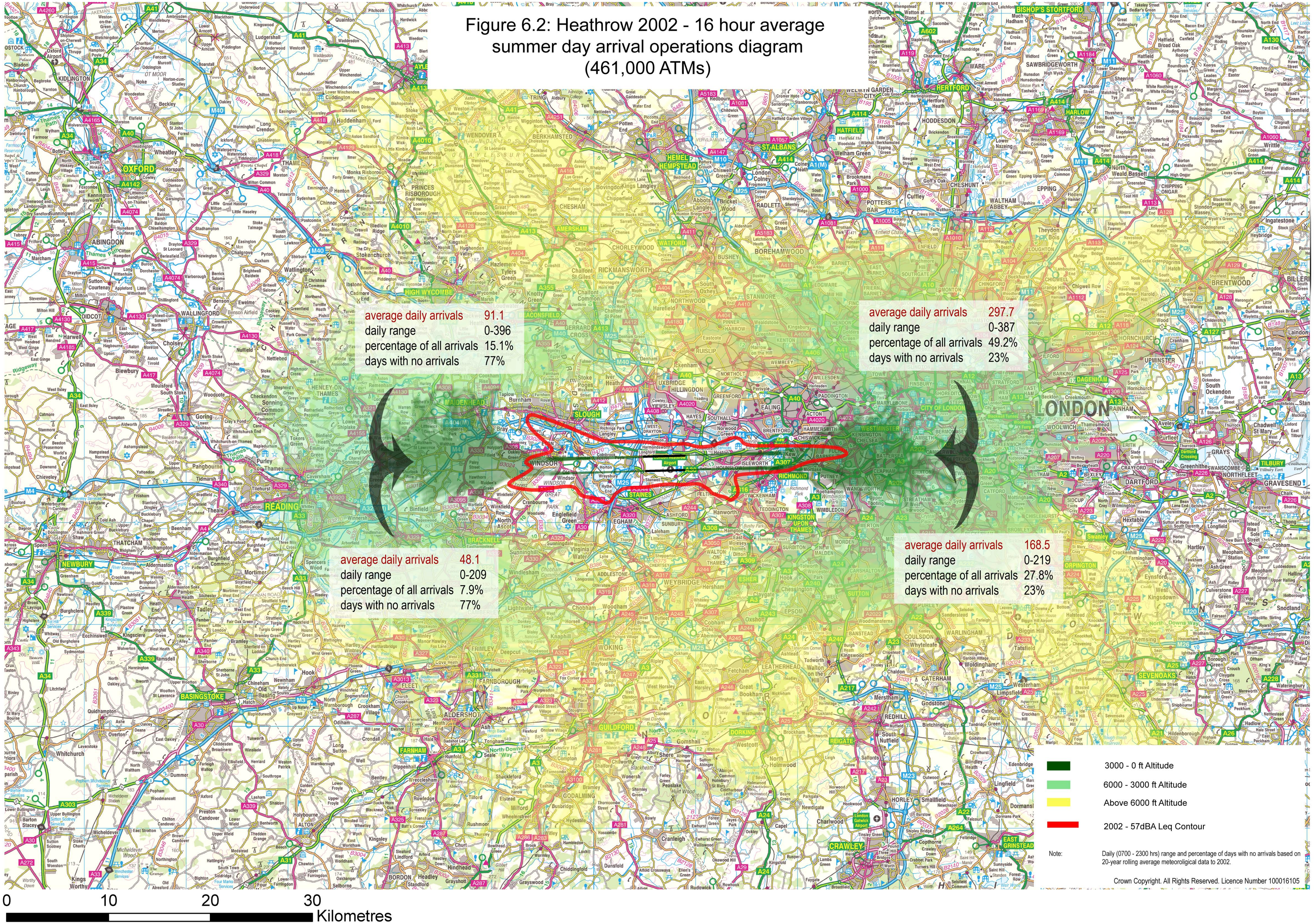


Figure 6.2: Heathrow 2002 - 16 hour average summer day arrival operations diagram (461,000 ATMs)

Figure 6.3: Heathrow 2015 mixed-mode - Indicative
16 hour average summer day departure operations diagram
(540,000 ATMs)

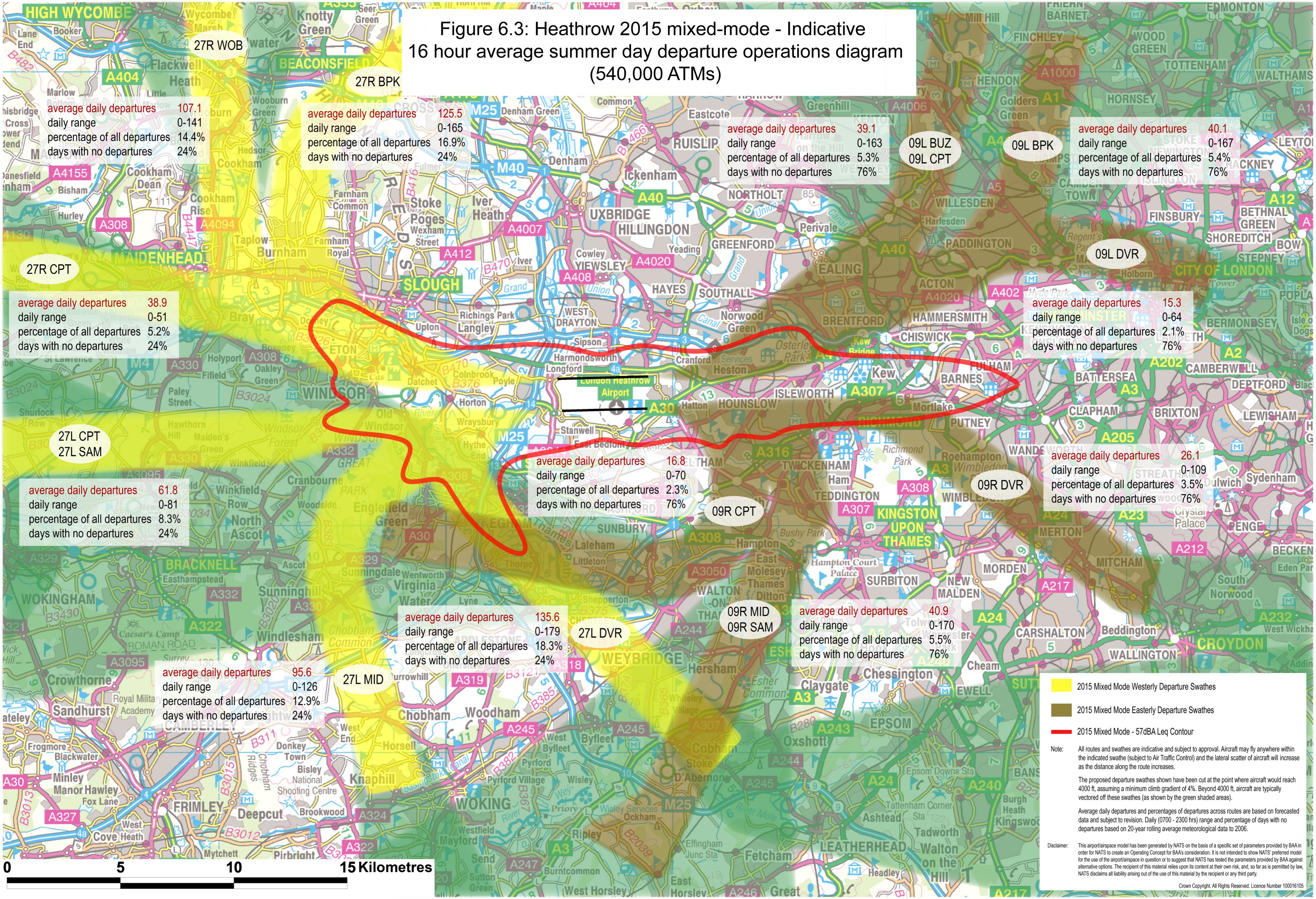


Figure 6.4: Heathrow 2015 mixed-mode - Indicative 16 hour average summer day arrival operations diagram (540,000 ATMs)

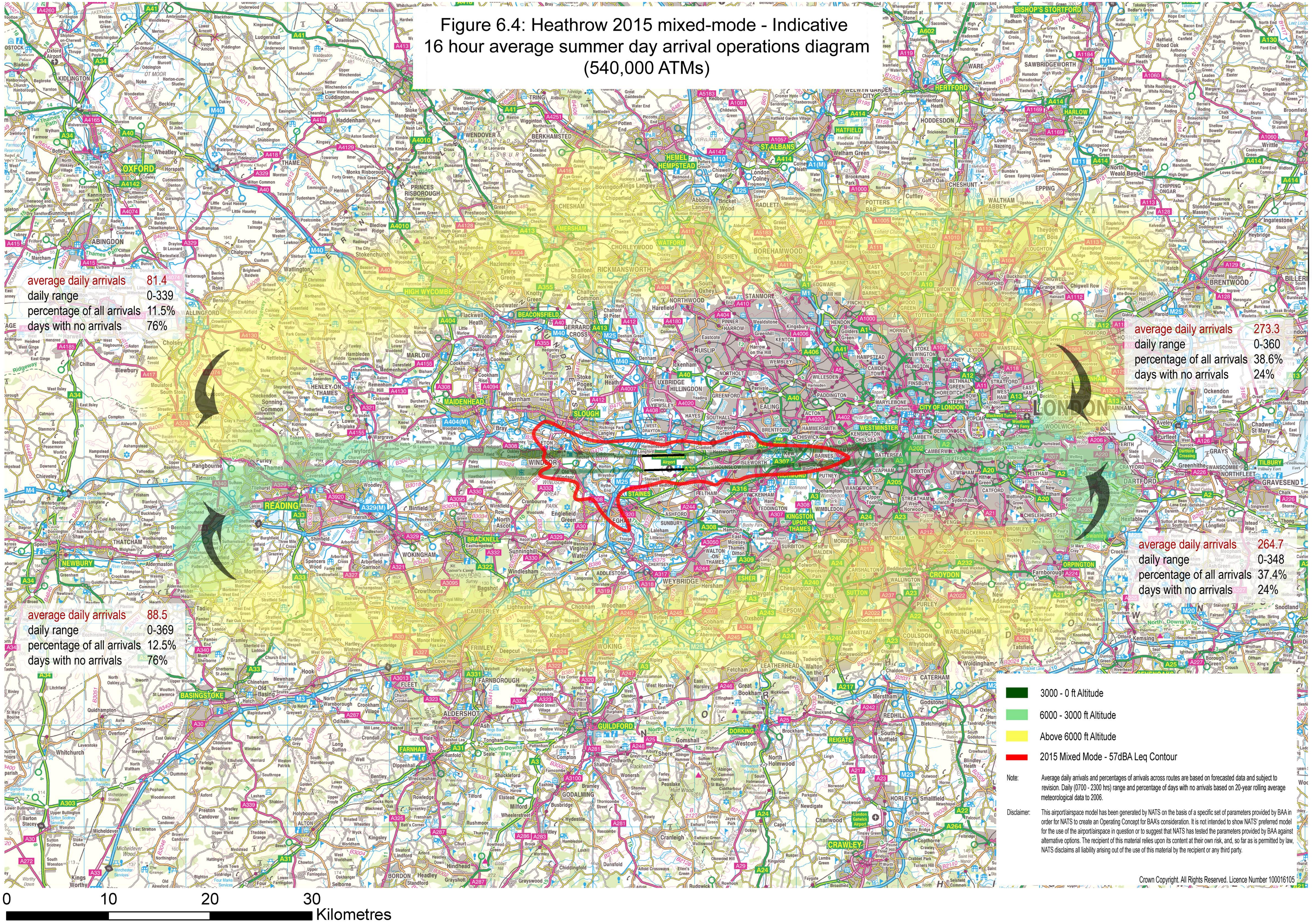


Figure 6.5 : Heathrow 2030 R3 MLD - Indicative
16 hour average summer day departure operations diagram
(702,000 ATMs)

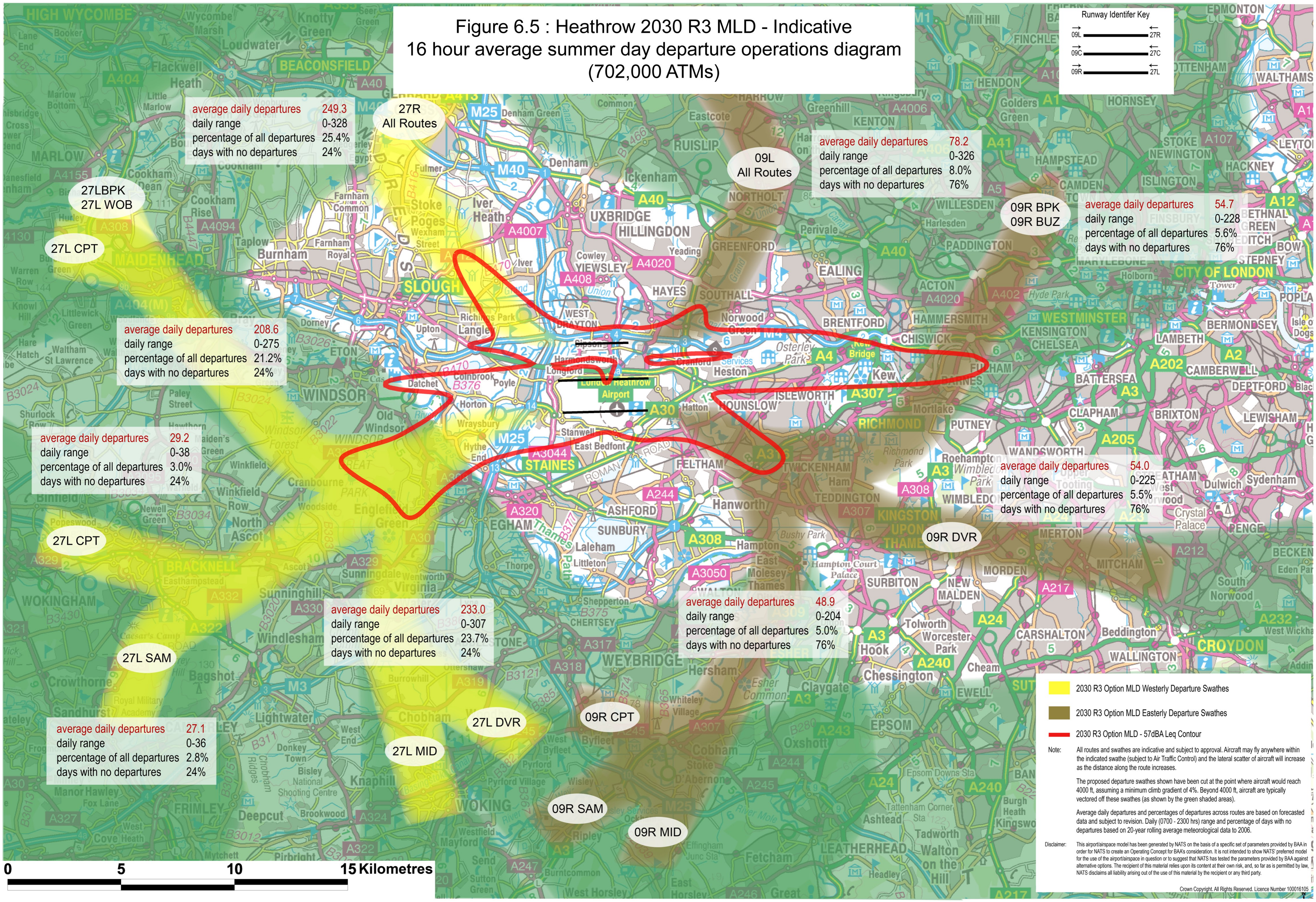
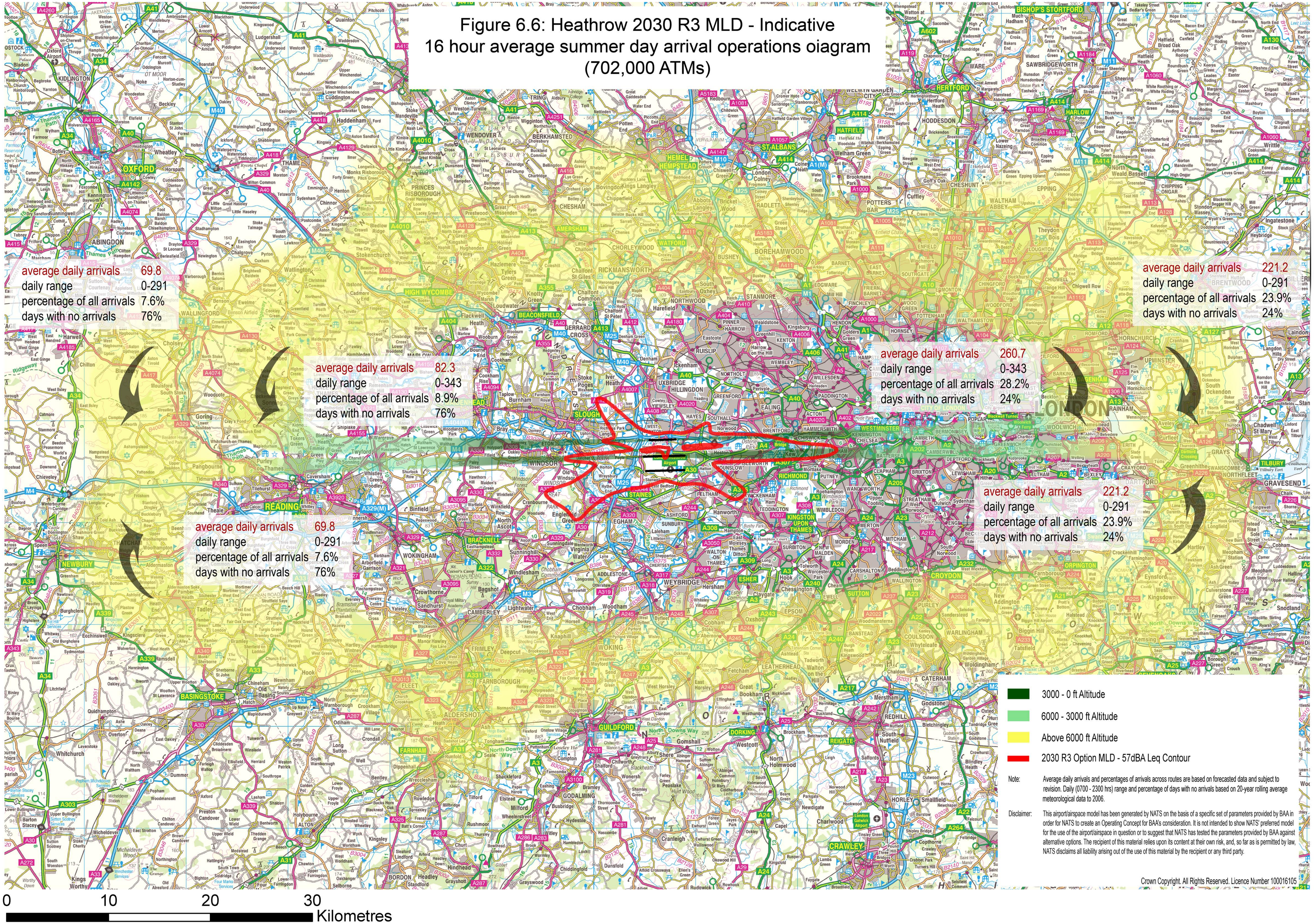


Figure 6.6: Heathrow 2030 R3 MLD - Indicative
16 hour average summer day arrival operations oiagram
(702,000 ATMs)



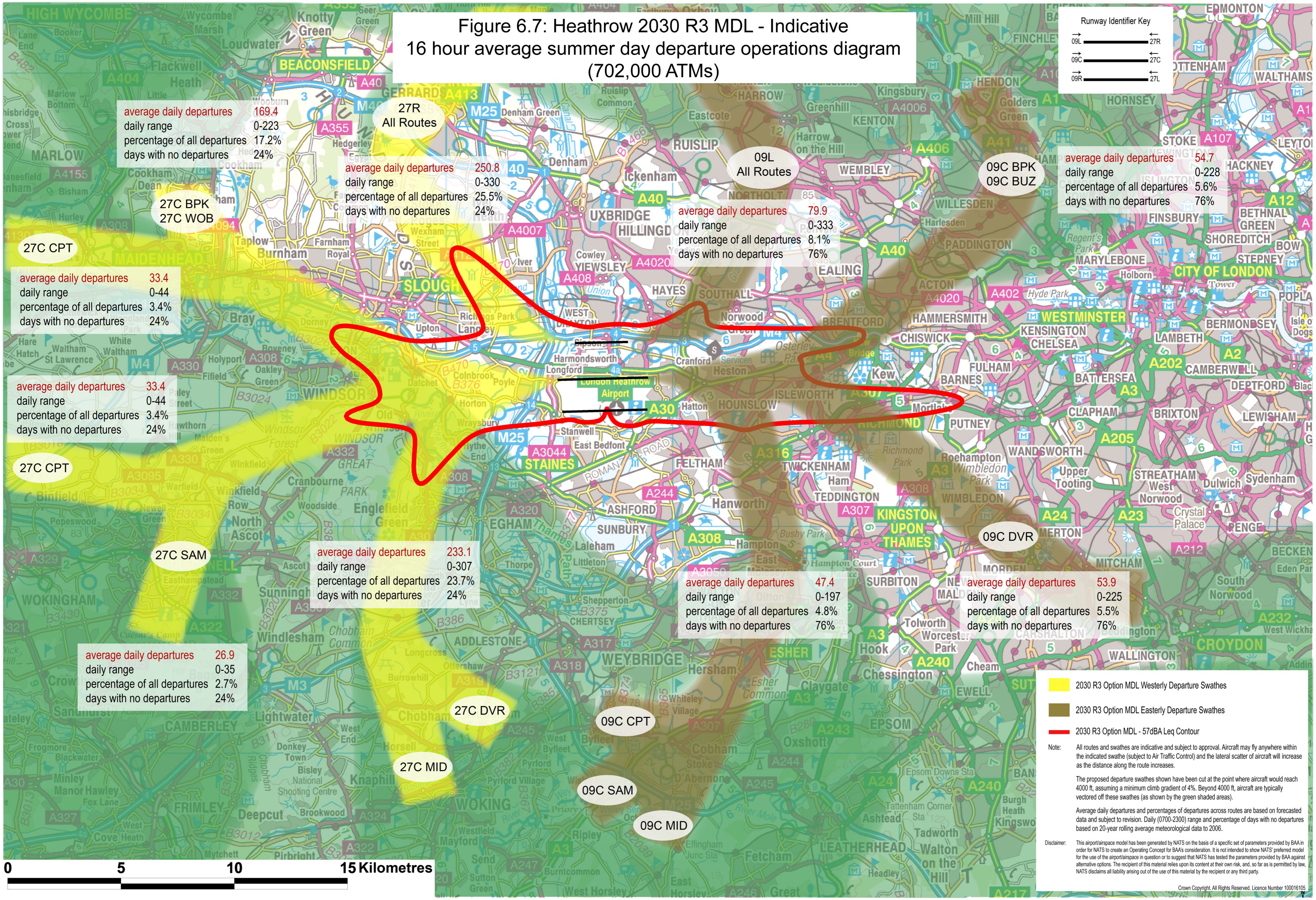


Figure 6.7: Heathrow 2030 R3 MDL - Indicative
16 hour average summer day departure operations diagram
(702,000 ATMs)
Runway Identifier Key
09L 27R
09C 27C
09R 27L
27R
All Routes
average daily departures 169.4
daily range 0-223
percentage of all departures 17.2%
days with no departures 24%
average daily departures 250.8
daily range 0-330
percentage of all departures 25.5%
days with no departures 24%
09L
All Routes
average daily departures 79.9
daily range 0-333
percentage of all departures 8.1%
days with no departures 76%
09C BPK
09C BUZ
average daily departures 54.7
daily range 0-228
percentage of all departures 5.6%
days with no departures 76%
27C BPK
27C WOB
27C CPT
average daily departures 33.4
daily range 0-44
percentage of all departures 3.4%
days with no departures 24%
average daily departures 33.4
daily range 0-44
percentage of all departures 3.4%
days with no departures 24%
27C CPT
27C SAM
average daily departures 233.1
daily range 0-307
percentage of all departures 23.7%
days with no departures 24%
average daily departures 47.4
daily range 0-197
percentage of all departures 4.8%
days with no departures 76%
09C DVR
average daily departures 53.9
daily range 0-225
percentage of all departures 5.5%
days with no departures 76%
average daily departures 26.9
daily range 0-35
percentage of all departures 2.7%
days with no departures 24%
27C DVR
09C CPT
27C MID
09C SAM
09C MID
London Heathrow Airport
0 5 10 15 Kilometres
2030 R3 Option MDL Westerly Departure Swathes
2030 R3 Option MDL Easterly Departure Swathes
2030 R3 Option MDL - 57dBA Leq Contour
Note: All routes and swathes are indicative and subject to approval. Aircraft may fly anywhere within the indicated swathe (subject to Air Traffic Control) and the lateral scatter of aircraft will increase as the distance along the route increases.
The proposed departure swathes shown have been cut at the point where aircraft would reach 4000 ft, assuming a minimum climb gradient of 4%. Beyond 4000 ft, aircraft are typically vectored off these swathes (as shown by the green shaded areas).
Average daily departures and percentages of departures across routes are based on forecasted data and subject to revision. Daily (0700-2300) range and percentage of days with no departures based on 20-year rolling average meteorological data to 2006.
Disclaimer: This airport/airspace model has been generated by NATS on the basis of a specific set of parameters provided by BAA in order for NATS to create an Operating Concept for BAA's consideration. It is not intended to show NATS' preferred model for the use of the airport/airspace in question or to suggest that NATS has tested the parameters provided by BAA against alternative options. The recipient of this material relies upon its content at their own risk, and, so far as is permitted by law, NATS disclaims all liability arising out of the use of this material by the recipient or any third party.
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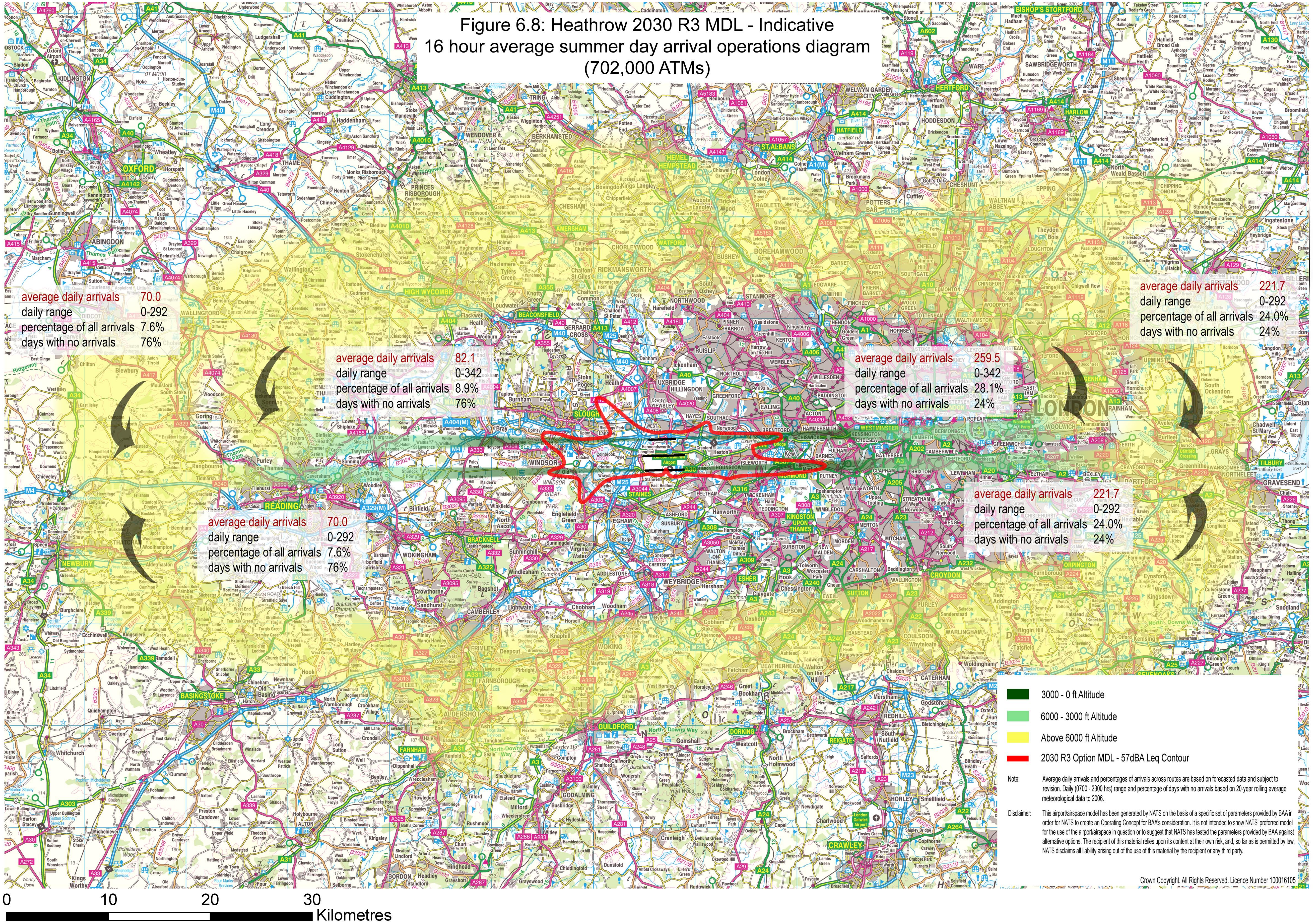
Figure 6.8: Heathrow 2030 R3 MDL - Indicative
16 hour average summer day arrival operations diagram
(702,000 ATMs)
average daily arrivals 70.0
daily range 0-292
percentage of all arrivals 7.6%
days with no arrivals 76%
average daily arrivals 82.1
daily range 0-342
percentage of all arrivals 8.9%
days with no arrivals 76%
average daily arrivals 259.5
daily range 0-342
percentage of all arrivals 28.1%
days with no arrivals 24%
average daily arrivals 221.7
daily range 0-292
percentage of all arrivals 24.0%
days with no arrivals 24%
average daily arrivals 70.0
daily range 0-292
percentage of all arrivals 7.6%
days with no arrivals 76%
average daily arrivals 221.7
daily range 0-292
percentage of all arrivals 24.0%
days with no arrivals 24%
3000 - 0 ft Altitude
6000 - 3000 ft Altitude
Above 6000 ft Altitude
2030 R3 Option MDL - 57dBA Leq Contour
Note: Average daily arrivals and percentages of arrivals across routes are based on forecasted data and subject to revision. Daily (0700 - 2300 hrs) range and percentage of days with no arrivals based on 20-year rolling average meteorological data to 2006.
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0 10 20 30 Kilometres